# SCIENCE



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CONTENTS:



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## *EARTH-CRUST MOVEMENTS AND THEIR CAUSES.* *

### INTRODUCTION.—SOURCES OF ENERGY.

NEARLY all the processes of nature visible to us—well-nigh the whole drama of nature enacted here on the surface of the earth—derive their forces from the sun. Currents of air and water in their eternally recurring cycles are a circulation driven by the sun. Plants derive their forces directly, and those of animals indirectly through plants, from it. All our machinery, whether wind-driven, or water-driven, or steam-driven, or electricity-driven, and even all the phenomena of intellectual, moral and social activity, have still this same source. There is one, and but one, exception to this almost universal law, namely, that class of phenomena which geologists group under the general head of *igneous agencies*, comprising volcanoes, earthquakes, and more gradual movements of the earth's crust.

* Annual address by the President, Joseph Le Conte, read before the Geological Society of America, December 29, 1896.

Thus, then, all geological agencies are primarily divided into two groups. In the one group came atmospheric, aqueous and organic agencies, together with all other terrestrial phenomena which constitute the material of science; in the other group, igneous agencies and their phenomena alone. The forces in the group are exterior; in the other, interior; in the one, sun-derived; in the other, earth-derived. The one forms, the other sculptures, the earth's features; the one rough-hews, the other shapes. The general effect of the one is to increase the inequalities of the earth's surface, the other to decrease and finally to destroy them. The configuration of the earth's surface, the distribution of land and water—in a word, all that constitutes physical geography at any geological time—is determined by the state of balance between these two eternally antagonistic forces.

### PHENOMENA TO BE STUDIED.

Now the phenomena of the first group, lying, as they do, on the surface and subject to direct observation, are comparatively well understood as to their laws and their causes. While the causes of the phenomena of the second group, hidden forever from direct observation in the inaccessible depths of the earth's interior, are still very obscure; and yet partly on account of this very obscurity, but mainly on account of their fundamental importance, it is just these which are the most fascinating to the geologist. The former group, constituting, as it does, the terrestrial drama enacted by the sun, its interest is shared by geology equally with other departments of science, such as physics, chemistry and biology. The phenomena of the second group are more distinctively the field of geology.

If we compare the earth with an organism then these interior forces constitute its life-force, while the other group may be likened to the physical environments against which it eternally struggles, and the outcome of this struggle determines the course of the evolution of the whole. Now in biological science nearly the whole advance has heretofore been by study of the external and more easily understood phenomena, thus clearing the ground and gathering material for attack on the interior fortress, and the next great advance must be through better knowledge of the vital forces themselves. The same is true of geology. Nearly all the progress has heretofore been by the study of the exterior phenomena, such as erosion, transportation, sedimentation, stratification, distribution of organic forms in space and their succession in time, etc. Many of the laws of these phenomena have already been outlined, and progress to-day is mainly in filling in and completing this outline; but the next great step must be through a better knowledge of the interior forces. This is just what geological science is waiting for to-day. Now the first step in this direction is a clear statement of the problems to be solved. The object of this address is to contribute something, however small, to such clear statement.

### EFFECTS OF INTERIOR FORCES.

As the interior of the earth is inaccessible to direct observation, we can reason concerning interior forces only by observation of their effects on the surface. Now these effects, as usually treated, are of three main kinds: (1) Volcanoes, including all eruptions of material from the interior; (2) Earthquakes, including all sensible movements, great and small; (3) Gradual small movements effecting large areas, imperceptible to the senses, but accumulating through indefinite time.

It is certain that of these three the last is by far the most fundamental and important, being, indeed, the cause of the other two.

Volcanoes and earthquakes, although so striking and conspicuous, are probably but occasional accidents in the slow march of these grander movements. It is only of these last, therefore, that we shall now speak.

KINDS AND GRADES OF EARTH-CRUST MOVEMENTS.

The movements of the earth's crust determined by interior forces are of four orders of greatness: (1) Those greatest, most extensive, and probably primitive movements by which oceanic basins and continental masses were first differentiated and afterward developed to their present condition; (2) those movements by lateral thrust by which mountain ranges were formed and continued to grow until balanced by exterior erosive forces; (3) certain movements, often over large areas, but not continuous in one direction, and therefore not indefinitely cumulative like the two preceding, but oscillatory, first in one direction, then in another, now upward and then downward; (4) movements by gravitative readjustment, determined by transfer of load from one place to another. Perhaps this last does not belong strictly to pure interior or earth-derived forces, since the transfer of load is probably always by exterior or sun-derived forces. Nevertheless they are so important as modifying the effects of other movements and have so important a bearing on the interior condition of the earth that they cannot be omitted in this connection.

Now of these four kinds and grades of movement the first two are primary and continuous in the same direction, and therefore cumulative, until balanced by leveling agencies. The other two, on the contrary, are not necessarily continuous in the same direction, but oscillatory. They are, moreover, secondary and are imposed on the other two or primary movements as modifying, obscuring, and often even completely masking their effects. This important point will be brought out as we proceed. We will take up these movements successively in the order indicated above.

1. *Ocean Basin-making Movements.*

I have already given my views on this most fundamental question very briefly in my 'Elements of Geology,' a little more fully in my first paper, 'Origin of Earth Features,'* and in my memoir of Dana.† I give it still more fully now.

We may assume that the earth was at one time an incandescent, fused spheroid of much greater dimensions than now, and that it gradually cooled, solidified, and contracted to its present form, condition and size. Now if at the time of its solidification it had been perfectly homogeneous in composition, in density and in conductivity in every part, then the cooling and contraction would have been equal on every radius, and it would have retained its perfect, evenly spheroidal form; but such absolute homogeneity in all parts of so large a body would be in the last degree improbable. If, then, over some large areas the matter of the earth were denser and more conductive than over other large areas, the former areas, by reason of their greater density alone, would sink below the mean level and form hollows; for even in a solid—much more in a semi-liquid, as the earth was at that time—there must have been static equilibrium (*isostasy*) between such large areas. This would be the beginning of oceanic basins; but the inequalities from this cause alone would probably be very small but for the concurrence of another and much greater cause, viz, the greater conductivity of the same areas. Conductivity is not, indeed, strictly proportional to destiny; but in a general way it is so. It is certain, therefore, that the denser areas would be also the more conduc-

*Am. Jour. Sci., 1872.

† Bull. Geol. Soc. Am., Vol. 7, 1895, pp. 461–474.

tive, and therefore the more rapidly cooling and contracting areas. This would again increase, and in this case progressively increase, the depression of these areas. The two causes — destiny and conductivity, isostasy and contraction—would concur, but the latter would be far the greater, because indefinitely cumulative. The originally evenly spheroidal lithosphere would thus be deformed or distorted, and the distortion, fixed by solidification, would be continually increased until now. When the earth cooled sufficiently to precipitate atmospheric vapor the watery envelope thus formed would accumulate in the basins of the lithosphere and form the oceans. It is possible, and even probable, that the depressions were at first so shallow that the primeval ocean may have been universal, but the process of greater downward contraction continuing, the ocean basins would become deeper and the less contracted portions of the lithosphere would appear as land. The process still continuing, the land would grow higher and more extensive and the ocean basins deeper and less extended throughout all geological time. On the whole, in spite of many oscillations, with increase and decrease of land, to be spoken of later, and in spite, too, of exterior agencies by erosion and sedimentation tending constantly to counteract these effects, such has been, I believe, the fact throughout all geological history.

It is evident, also, that on this view, since the same causes which originally formed the ocean basins have continued to operate in the same places, the positions of these greatest inequalities of the lithosphere have not substantially changed. This is the doctrine of the permanency of oceanic basins and continental masses, first announced by Dana. Some modification of this idea will come up under another head.

The objection which may be—which has been—raised against this view is that such heterogeneity as is here supposed, in a fused mass and therefore in a mass solidified from a state of fusion, is highly improbable, not to say impossible. This objection, I believe, will disappear when we remember the very small differences in conductivity, and therefore in contraction, that we are here dealing with; small, I mean, in comparison with the size of the earth. This is evident when we consider the inequalities of the earth's surface. The mean depth of the ocean is about two and one-half miles; the mean height of the land, about one-third of a mile. The mean inequality of the lithosphere, therefore, is less than three miles. This is $\frac{1}{1800}$ of the radius of the earth—less than $\frac{1}{100}$ of an inch (an almost imperceptible quantity) in a globe two feet in diameter. I believe that a perfectly spheriodal ball of plastic clay allowed to dry, or even a spheriodal ball of red-hot copper allowed to cool, would show more deformation by contraction than the lithosphere of the earth in its present condition. It is true the inequalities are more accentuated in some places, especially on the margins of the continental areas; but this is due to another cause, mountain-making, to be taken up later.

Another objection will doubtless occur to the thoughtful geologist. It would seem at first sight on this view that ocean areas cooling most rapidly ought to be the first to form a solid crust, and the crust (if there be any interior liquid still remaining) ought to be thickest, and therefore least subject to volcanic activity, there; but, on the contrary, we find that it is just in these areas that volcanoes are most abundant and active. It is for this reason that Dana believed that land areas were the first and ocean areas the last to crust over. This is probably true; but a little reflection will show that these two facts, namely, the earlier crusting of the land areas and the more rapid cooling and contraction of the

ocean areas, are not inconsistent with one another; for the more conductive and rapidly cooling areas would really be the last to crust, because surface solidification would be delayed by the easy transference of heat from below, while the less conductive land areas would certainly be the first to crust, because the non-conductivity of these areas would prevent the access of heat from below. Observation of lavas proves this. The most vesicular and non-conductive lavas are the soonest to crust, but for that very reason the slowest to cool to great depths.

No doubt many other objections may be raised, especially if we attempt to carry out the idea into detail; for the physical principles involved, and especially the conditions under which they acted, are far too complex and imperfectly understood to admit of such detail. It is safest, therefore, to confine ourselves to the most general statement.

It may be well to stop a moment to compare with the above view that of Dana, as interpreted and clearly presented by Gilbert in 1893.* (1) According to this view the earth is supposed to have first solidified at the center. This, on the whole, seems most probable. (2) The investing liquid, say from 50 to 100 miles thick, might well be supposed to arrange itself in layers of increasing density from the surface to the solid nucleus. Now suppose for any cause, less conductivity or other, certain areas crusted on the surface. These crusts would, of course, consist of the lighter superficial portions; but since rocks contract in the act of solidification,† these solidified crusts would sink to the nucleus and be replaced by similar lighter material flowing in from the surrounding surface, which in turn would solidify and sink. Thus would be built up from the nucleus below a solid mass consisting only of the superficial, lighter material to form the land, while the denser and less rapidly crusting material would form the ocean areas. As in my view, therefore, the oceanic areas are the denser and the land areas the lighter material.

It is evident that, according to either view, but especially according to mine, the material of the ocean basin areas down to the center of the earth must be as much denser than the material of the land areas down to the center as the subocean radii are shorter than the subcontinental radii, and therefore that the two areas must be in perfect static equilibrium with one another. Thus in the formation of continents the claims of isostasy are completely satisfied. I say completely because this is not a partial equilibrium resisted by rigidity but enforced by pressure; it is original and without stress.

2. *Mountain-making Movements.*

I have so recently discussed this subject* that I shall have little more to say now. Mountain ranges are of two types, namely, the anticlinal or typical and the monoclinal or exceptional. The one are mountains of folded structure, determined by lateral thrust, the other of simpler structure and determined by unequal settling of great crust blocks. It is only of the former that I shall speak now. The other or monoclinal type will come up under another head.

It will not be questioned that mountain ranges of the first type are formed by lateral thrust, however much we may differ as to the cause of such thrust; nor will it be questioned that they are permanent features determined by continuous movement, however much they may be modified by other kinds of movement or reduced or even destroyed by subsequent erosion. I have placed them, therefore, among the effects of

* Bull. Geol. Soc. Am., Vol. 4, 1893, p. 179.

† King and Barus. Am. Jour. Sci., Vol. 45, 1893, p. 1.

* President's address, Am. Asso. Adv. Sci., Madison meeting, 1893.

primary movements—that is, movements determined by causes affecting the whole earth. I have done so because until some more rational view shall be proposed I shall continue to hold that they are the effects of interior contraction concentrated upon certain lines of weakness of the crust and, therefore, of yielding to the lateral thrust thus generated. The reason for, as well as the objections to, this view I have already, on a previous occasion, fully discussed. I wish now only to supplement what I have before said by some further criticisms of the most recent and, some think, the most potent objection to this contractional theory, namely, that derived from the supposed position of the 'level of no strain.'

It is admitted that the whole force of this objection is based on the extreme superficiality of this level, and that this, in its turn, depends on the initial temperature of the incandescent earth and the time elapsed since it began to cool. Both these are admitted to be very uncertain. I have already discussed these in my previous paper and shall not repeat here; but, as recently shown by Davison,* there are still other elements, entirely left out of account in previous calculations, which must greatly affect the result, and these new elements all concur to place the level of no strain much deeper than previous calculations would make it.

These neglected elements are the following: (1) The earth increases in temperature as we go down. Now the coefficient of contraction increases with temperature. This would increase the depth of the level of no strain, and also, of course, the amount of interior contraction and, therefore, the lateral thrust. (2) The conductivity increases with the temperature. This also would increase the rate of cooling and, therefore, of interior contraction. (3) The interior of the earth is more conductive not only on account of its greater temperature, but also on account of its greater density; and this would be true whether the greater density be due to increased pressure or to difference of material, as, for example, to greater abundance of unoxidized metals. (4) The materials of the interior, aside from greater temperature and density, have a higher coefficient of contraction. (5) The usual calculations go on the assumption that the initial temperature was uniform for all depths. It probably increased with the depth then as now. This would again increase in an important degree both the depth of the level of no strain and the amount of lateral thrust.

The final result reached by Davison is, that while according to the usual calculations the level of no strain may be only a little over two miles (2.17) below the surface, yet, taking into account only the first element mentioned above, the depth of that level would be increased to nearly eight miles (7.79), and taking into account all the elements it would come out many times greater still. The general conclusion arrived at is that the objections to the contractional theory, based on the depth of the level of no strain, must be regarded as invalid.

3. *Oscillatory Movements.*

The movements thus far considered are continuously progressive in one direction as long as they last. The resulting features are therefore permanent, except in so far as they may be modified by other movements or by degrading influences; but nothing is more certain than that besides these more steady movements there have been others of a more oscillatory character—that is, upward and downward—in the same place, affecting now smaller, now larger areas, and often many times repeated. These are the most common of all crust movements, and are shown everywhere and in all periods of the earth's history by unconformities of the

*Am. Jour. Sci., Vol. 47, 1894, p. 480. Phil. Mag., Vol. 41, 1896, p. 133.

stratified series. Every line of unconformity marks an old eroded land surface, and every conformable series of strata a sea bottom receiving sediments. We give but two striking examples of such oscillations.

The Colorado plateau was a sea bottom, continuously or nearly so, from the beginning of the Carboniferous to the end of the Cretaceous, and during that time received about 12,000 or 15,000 feet in thickness of sediments. During the whole of this time the area of the earth's crust was slowly sinking and thus continually renewing the conditions of sedimentation. Why did it subside? At the end of the Cretaceous the same area began to rise. What change of conditions caused it now to rise? It has continued to rise until the present time, and is still rising. The whole amount of rise cannot be less than 20,000 feet; for if all the strata which have been removed by erosion were again restored, the highest portion of the arch which was sea bottom at the end of the Cretaceous would now be 20,000 feet high. This, however, is only the last oscillation of this area, for beneath the Carboniferous there are several unconformities showing several oscillations of the same kind in earlier periods. During the Devonian the area was land, for the Carboniferous rests unconformably on the Silurian. During the Silurian it was sea bottom, receiving sediments of that time. Beneath the Silurian there are two other unconformities showing similar oscillations. These earlier oscillations were probably as great as the one now going on, but we cannot measure them as we can the last.

Another striking example, still more recent and widespread, is the enormous oscillations of the Glacial period. It cannot be doubted that over very wide areas—several millions of square miles—there were at that time upward and downward movements of several thousand feet, and therefore producing enormous changes in physical geography and climate. What was the cause of these movements? They were doubtless modified, as will be shown later, by other movements superimposed on them; but the causes of the latter must not be confounded with that of the former.

We have given only two striking examples, but they are really the commonest of all crust movements. They are everywhere marked by unconformities of the strata; they are everywhere going on at the present time. In some places the sea is advancing on a subsiding land; in others a rising land is advancing on the sea. These movements are more conspicuous along coastlines, because the sea is a datum level by which to measure them, but they affect equally the interior of continents, as shown by the behavior of the rivers, which seek their base level by erosion in a rising and by sedimentation in a sinking country.

Many theories have been advanced to explain these movements, especially of certain very local shoreline movements. In volcanic regions they have been attributed to rise or recession of the volcanic heat and consequent columnar expansion or contraction of the crust. On non-volcanic sedimentary shorelines elevation has been attributed by some to the rise of the interior heat of the earth and conseqent expansion of the crust produced by the blanketing effect of sedimentary deposit; while others, with more reason, think that regions of heavy sedimentation sink under the increasing load of accumulating sediments; but it is evident that, while such theories may explain some local examples in volcanic regions and along some shorelines, they cannot explain subsidences in the interior of continents, much less the wider and more extensive movements spoken of above. We must look for some more general cause. What is it?

It must be confessed that the cause of

these oscillatory movements is the most inexplicable problem in geology. Not the slightest glimmer of light has yet been shed on it. I bring forward the problem here, not to solve it, for I confess my inability, but to differentiate it from other problems, and especially to draw attention to these movements as modifying the effects of movements of the first kind, and often so greatly modifying them as to obscure the principle of the permanency of oceanic basins and continental areas, and even to cause many to deny its truth. Nearly all the changes in physical geography in geological times, with their consequent changes in climate and in the character and distribution of organic forms—in fact, nearly all the details of the history of the earth—have been determined by these oscillatory movements; but amid all these oscillatory changes, sometimes of enormous amount and extent, it is believed that the places of the deep oceanic basins and of the continental masses, being determined by other and more primary causes, have remained substantially the same.

4. *Movements by Gravitative Readjustments—Isostasy.*

This very important principle which, though partially recognized by Herschell, was first clearly enunciated by Major Dutton under the name isostasy.* The principle may be briefly stated thus: In so large a mass as the earth, whether liquid within or solid throughout it matters not, excess or deficit of weight over large areas cannot exist permanently. The earth must gradually yield fluidally or plastically until static equilibrium is established or nearly so. Thus continuous transfer of material from one place to another by erosion and sedimentation must be attended with sinking of the crust in the loaded and rising of the crust in the unloaded area. In this way we may account for the sinking of the crust at the mouths of great rivers and the correlative rising of interior plateaus and nearly all great mountain regions observable at the present time. The same seems to have been true in all geological times, for it is obviously impossible that 40,000 feet of sediments could have accumulated in the Appalachian region in preparation for the Appalachian's birth unless there were continuous *pari passu* subsidence ever renewing the conditions of sedimentation.

Now there can be no doubt as to the value of this principle, but there is much doubt as to the extent of its application. The operation of exterior causes, such as transfer of load by erosion and sedimentation, are so comparatively simple and their effects so easily understood that we are tempted to push them beyond their legitimate domain, which in this case is to supplement and modify the more fundamental movements derived from interior causes. We are thus tempted to generalize too hastily and to conclude that all subsidence is due to weighting and all elevation to removal of weight. Probably this is a true cause, but not the main cause of such movements. Doubtless the proposition is true, but its converse is even much more so. It is certain that thick sediments may cause subsidence, but it is much more certain that subsidence, however determined, will cause continuous sedimentation by ever renewing the conditions of sedimentation. It is true that removal of weight by erosion will cause elevation, but it is more certain that elevation is the cause of removal of matter by erosion.

Take again the Plateau region as an example. We have seen that during the whole Carboniferous, Permian, Triassic, Jurassic and Cretaceous times this region was subsiding, until at the end of the Cretaceous the earth's crust here had bent downward 12,000 or 15,000 feet. Shall we say it went down under the increasing load of

* Phil. Society of Washington, 1892.

sediments? Why, then, did it, from a previous land condition, ever commence to subside? And why, when the load was greatest, namely, at the end of the Cretaceous, did it begin to rise? Again, from that time to this it has risen 20,000 feet? Of this, about 12,000 feet have been removed by erosion, leaving still 8,000 feet of elevation remaining. Now if this elevation be the result of removal of weight by erosion, how is it that a removal of 12,000 feet has caused an elevation of 20,000 feet? This result is natural enough, however, if elevation was the cause and erosion the effect, for the effect ought to lag behind the cause. It is evident, then, that we must look elsewhere —that is, in the interior of the earth—for the fundamental cause, although, indeed, the effects of this interior cause may be increased and continued by the addition and removal of weight.

But perhaps the best illustration of the distinctness of the two kinds of causes of these movements is found in the oscillations of the Quaternary period. I say best because in this case the effects of the two may be disentangled and viewed separately, and this in its turn is possible because the loading in this case is not by mere transfer from one place to another, and therefore is not correlated with unloading. In fact, the elevation in this case is associated with, and in spite of, loading. The elevation, as we all know, commenced in late Tertiary and culminated in early Glacial. This elevation was, at least, one cause, probably the main cause, of the cold and the ice accumulation, but the elevation continued in spite of the accumulating load of ice. Finally, however, the accumulating load prevailed over the elevating force and the previously rising area began to sink, but only because the interior elevatory forces had commenced to die out. Then with the sinking commenced a moderation of the climate, melting of the ice, removal of load, and consequent rising of the crust to the present condition, but far below the previous elevated condition, because the elevating forces, whatever these were, had in the meantime exhausted themselves. If it had not been for the interference of the ice load, I suppose that instead of the double oscillation which actually occurred there would have been a simple curve of elevation coming down again to the present condition, but culminating a little later and rising a little higher than we actually find it did.

The question arises as to how great an area is necessary for the operation of the principle of isostasy? What extent and degree of inequality of surface may be upheld by earth rigidity alone?

The recent transcontinental gravitation determinations by Putnam and their interpretation by Gilbert* seem to show a degree of rigidity greater than previously supposed. They seem to show that while the whole continental arch is certainly sustained by isostasy—that is, by deficiency of density below the sea level in that part, the continental area being lighter in proportion as it is higher—yet great mountain ranges like the Appalachian, Colorado and Wasatch mountains show no such means of support, but are bodily upheld by earth rigidity; and even great plateaus, like the Colorado plateau, 275 miles across, are largely, though not entirely, sustained in the same way.

*Monoclinal Mountain Ranges.*

Until recently, mountain ranges were supposed to be all made in one way, namely, by lateral crushing and strata-folding and bulging along the line of yielding. To Gilbert is due the credit of having first drawn attention to another type, conspicuously represented only in the Plateau and Basin region, especially the latter—that is, those pro-

*Gilbert: Phil. Soc. Washington, Vol. 13, 1895, p. 31. Gilbert: Jour. Geology, Vol. 3, 1895, p. 331. O. Fisher: Nature, Vol. 52, 1895, p. 433.

duced by tilting and irregular settling of the crust blocks between great fissures. The two types of mountains are completely contrasted in all respects. As to form, the one is anticlinal, the other monoclinal. As to cause, the one is formed by lateral squeezing and strata-folding, the other by lateral stretching, fracturing, block-tilting and unequal settling. As to place of birth, the one is born of marginal sea bottoms, the other is formed in the land crust. Classified by form, we may regard the two types as belonging to the same grade of earth features, namely, mountain ranges; but classified by their generating forces, they belong to entirely different groups of earth movement. The one belongs to the second group mentioned above, the other to the third and fourth groups; for the plateau-lifting, crust-arching and consequent tension and fracturing belong to the third group or oscillatory movements, but the mountain-making proper—that is, the subsequent block-tilting and unequal settling—belongs to the fourth group or isostasy, for that is wholly the result of isostatic readjustment and is one of the best illustrations of this principle. It shows on what comparatively small scale under favorable conditions (probably unstable foundation) the principle of isostasy may act. It is evident, then, that it is impossible to exaggerate the distinction between these two types of mountains. They belong, as we have seen, to entirely different categories of interior forces, and, indeed, are not both mountains in the same sense at all. It was for this reason that, in my paper on mountain structure,* I put these latter in the category of mountain ridges instead of mountain ranges—of modification, not of formation. I now think it better to divide mountain ranges into two types, not forgetting, however, the very great distinction between them.

* Am. Jour. Sci., Vol. 16, 1878, p. 95.

*Conclusions.*

To sum up, then, in a few words: There are two primary and permanent kinds of crust movements, namely: (*a*) those which give rise to those greatest inequalities of the earth's surface—oceanic basins and continental surfaces; and (*b*) those which by interior contraction determine mountains of folded structure. These two are wholly determined by interior forces affecting the earth as a whole, the one by unequal radial contraction, the other by unequal concentric contraction—that is, contraction of the interior more than the exterior. There are also two secondary kinds of movement, which modify and often mask the effects of the other two and confuse our interpretation of them. These are: (*c*) those oscillatory movements, often affecting large areas, which have been the commonest and most conspicuous of all movements in every geological period, and are, indeed, the only ones distinctly observable and measurable at the present time, but for which no adequate cause has been assigned and no tenable theory proposed; and (*d*) isostatic movements or gravitative readjustments, by transfer of load from place to place, by erosion and sedimentation, or else loading and unloading by ice accumulation and removal, and also by readjustment of great crust blocks. If the previous one (*c*) or oscillatory movements have masked and so obscured the effects of (*a*) continent and ocean basin-making, this last (*d*), isostasy, has concealed the effects and obscured the interpretation of all the others, but especially of (*b* and *c*) mountain-making forces and the forces of oscillatory movements. In fact, in the minds of some recent writers it has well-nigh monopolized the whole field of crust movements. We shall not make secure progress until we keep these several kinds of movements and their causes distinct in our minds.

Joseph Le Conte.

## NOTES ON CERTAIN BELIEFS CONCERNING WILL POWER AMONG THE SIOUAN TRIBES.

WILHELM VON HUMBOLDT, in his memoir upon 'The American Verb,' in summing up the results of his profound study, makes the following statement (I quote from the translation of Dr. Daniel G. Brinton): "The leading and governing part of speech in them [the American languages under consideration] is the Pronoun; every subject of discourse is connected with the idea of Personality."

The Siouan linguistic group was not included in the number of languages concerning which the learned author made this statement, but, as the group presents no evidence to controvert his general conclusion, it may be considered as forming no exception to this characteristic of the American tongues.

It is not the purpose of this brief paper to discuss linguistic questions, but to call your attention to certain words, customs and ceremonies in which we seem to trace the operation of that psychic peculiarity which has left so marked an impress upon the languages of the American people—the dominance of 'the idea of Personality.'

In considering the emblematic use of the tree in the Dakotan group, the Siouan Indian's anthropomorphic conception of nature was pointed out, and the fundamental reason of this conception was indicated as lying in his predicating of the permeating life of the universe, that peculiar quality or power of which he as a man was conscious within himself, to wit, the power by which he directed his own acts, or willed a course by which to bring about certain results. This quality or power he may be said to have deified under the term Wa-kan-da (using the Omaha and Ponka tongue), the hidden and mysterious power which brings to pass.

The name of that by which a man thinks, feels and wills, is called in the Omaha language Wa-zhin'. A glance at some of the terms in which Wa-zhin' is used will illustrate the mental conception of which the word is an expression.

Wi'-e-wa-zhin means, to do a thing of one's own accord, of one's free will, unbiased or uninfluenced by another. (Wi, I; e, the sign of objective; wa-zhin', directive energy or will power.)

When the Omaha first saw a railroad train, and watched it moving along without any visible aid from man or animal, they gave it the name which it bears in their language to-day, E'-wa-zhin-non-ge, literally translated, "it of its own accord runs." (E, it; wa-zhin', will power; non-ge, runs.) The childlike simplicity of this descriptive term throws light upon the meaning of wa-zhin', and helps us to understand other words whereof it forms a part.

Anger is called Wa-zhin'-pi-a-zhi. Pi-a-zhi signifies bad, evil. Wa-zhin'-pi-a zhi indicates that in anger the will power of the man is charged with evil, and he becomes dangerous to himself and to others.

A very different condition of mind is represented by the Word Wa-zhin'-tha-be, which denotes kindness, and also hospitality. Tha-be' is to be guarded, circumspect in one's words and acts; so we learn that the idea of kindness is to use one's will power to guard one's speech and conduct, so as not to injure any one. In the employment of this word to express the idea of hospitality we discern the broadening of the social feeling through the growth of the higher sentiments.

Wa-zhin'-thne-de, the word for patience, presents another aspect of the idea of self-control. Thne-de means long. To be patient, therefore, demands that the energy of the Ego shall be held for a length of time to a given course.

Examples could be multiplied showing the use of wa-zhin' in compounding words,

but I will mention only three more instances—three words which are used in connection with certain rites and customs, where, while they serve to explain the ceremonies, the ceremonies themselves throw light upon the psychic phenomena which the words are intended to portray. These three words are, Wa-zhi*n*′-dhe-dhe, Wa-zhi*n*′-a-gdhe and Wa-zhi*n*′-ska.

There is hardly an equivalent in English for the word Wa-zhi*n*-dhe-dhe, unless it is 'telepathy.' Dhe′-dhe is to send, and the word wa-zhi*n*′-dhe-dhe signifies to send forth one's thought and will power toward another in order to supplement his strength and thereby to affect his action. For instance, when a race is taking place, a man may bend his thought and his will upon one of the contestants, a friend or relative, in the belief that this act of his, this 'sending his mind,' will help his friend to win. Again, among the Omahas, when a man is on the war path, a group of women often of the poorer class, will gather at the tent of the absent warrior, and sing certain songs, called We-to*n*-wa-a*n*. These songs are the medium by which strength is conveyed to the man facing danger; the act is Wa-zhi*n*′-dhe-dhe. The words of these songs do not reveal the purpose for which they are sung; they sometimes refer to the difficult task that confronts the warrior, or they predict the bravery of the absent man when he shall meet the enemy, but the omission of any reference in them to the specific act of which the songs are a part is in keeping with the Indian's habit never to dilate upon that which is to him apparent. The family of the absent warrior, to whose tent the women have come to sing these We-to*n*-wa-a*n*, know what the songs are for, and so do all the people within reach of the sound of them. These songs, used solely for the purpose of Wa-zhi*n*′-dhe-dhe, are well known and form a class by themselves, and the belief in their power is unquestioned.

Other tribes in the Siouan group have similar methods to effect the same purpose, all bearing witness to the common belief among these Indians that will power can be projected to produce definite results.

Although a literal translation of Wa-zhi*n*′-a-gdhe (a′-ghde, to place upon) might seem at the first glance to indicate that the word had the same meaning as Wa-zhi*n*′-dhe-dhe (which, as we have just seen, is to send will power), the word really presents a very different phase of the belief we are considering. Wa-zhi*n*′-a-gdhe is the will power placed upon, that is the full consequence of a certain line of conduct are willed to fall upon the person who, of his own accord, has determined on that line of conduct. In ordinary speech the word is used when one abandons another to the natural outcome of unwise behavior, and ceases all efforts to arrest the consequent disastrous results.

This word is used to define a rite peculiar to the Ha*n*′-he-wa-chi. Ha*n*′-he-wa-chi means literally, 'in the night dance,' but the word refers to the dream or vision of the members. The Ha*n*′-he-wa-chi is a society composed of men who have achieved the right to put the Mark of Honor on a maiden. To do this, a man must be able to count one hundred or more deeds called Wa-dhi*n*′-e-dhe. When an Omaha reached that point he could look back over years of patient effort, of self-denial and dangers overcome; so long a time did it require for a man to arrive at this Honor that its acquisition was esteemed equal to the receiving of a vision. It was argued that the man must have had supernatural favor granted him or he could not have finally accomplished his purpose. This society was therefore regarded as composed of men possessing great power of mind and will, and they were accordingly looked up to in

the tribe. Each member had his own song or songs, and when they met together a part of the ceremony observed by them was the singing of these songs. If at such a time they fixed their minds upon a certain person whose conduct was displeasing to them they thus, by the act of Wa-zhi*n*′-a-gdhe, placed upon the offender the consequences of his acts, so that misfortune would befall him, and even death. It will be noted that this act of the society implied the exertion of a will power by its members which it was believed could isolate the object of their thought—their victim, we may say—and this isolation was effected in some way by thrusting him out of all helpful relations with men and animals, and in the end causing him to die.

Time forbids dwelling upon this curious and interesting belief, or noting the cumulative influence it exerted upon the individual, and upon the social conditions of the community that entertained it; all that can be pointed out at this time is the fact that such a belief was genuinely accepted by these Indians.

Wa-zhi*n*′-ska means intelligence, discernment, wisdom. Ska is white, or clear. The word has a broad significance, based upon the natural experience of seeing. When the atmosphere is clear a man can distinguish objects, note their pecularities, and their relation to each other; so, when the mind is clear, it is said the man's ability to know is not checked by dimness of apprehension, but because of the clear white light within his mind he is able to exercise the power of discrimination, and to discern that which will be conducive to the best interests of himself and others, and thus attain to wisdom.

Wa-zhi*n*′-ska is the word which designates the time when a youth, having passed the period of childhood, has reached the stage where he can enter upon a season of fasting and prayer in order to secure a vision. The mind of the child is said to be dark; he is like one in the night, unable to distinguish objects; as he grows older, light begins to dawn, and when he can distinctly remember and can place in order the sequence of events of which he has been cognizant, then his mind is said to be becoming 'white,' and he is approaching the suitable mental condition to enter upon the rite which may bring him into personal relations with Wa-ka*n*′-da, as manifested in concrete form through the medium of the vision. The use of the word Wa-zhi*n*′-ska to indicate this period in the life of a man is significant in view of the meaning of the word itself, and of the importance to the man of the rite he is about to practise.

The potentiality of the vision and its formative influence, as revealed in the development of the tribe, we have already discussed; the point to be emphasized just now is that in the rite by which the Indian seeks the potent vision the idea of his personality is kept intact.

It is of importance to observe in this connection that this rite, which is supposed to open to man the means by which his own powers may be supernaturally augmented, is not under the control of any priesthood or dependent upon any esoteric teaching; nor does it require that the individual merge himself in a society and have only a common right in the supernatural manifestation; nor does he through this rite come under the domination of any set of men. On the contrary, the rite is free and open to every individual who may elect to enter upon the seclusion and fasting and prayer incident to the seeking of a vision, and the securing of the sign that shall ever after be a credential with Wa-ka*n*-da. This sign is always the man's personal and sacred possession; it is something that no one can tamper with, nor can any one deprive him of its benefits.

This rite of the vision, which there is

reason to think is a very ancient one, bears testimony to the Indian's intense feeling of personality, a personality that to a degree was supposed to control the very vision itself; for the potency of the manifestation vouchsafed to a man in his vision was judged by the quality of the man's acts in after life. It was believed that a man of weak will and mind could not be the recipient of a vision that would give him great power, because such a man would not be capable of receiving such a manifestation from Wa-ka*n*-da. Thus the quality of a man's vision, which was to supplement his natural strength by supernatural power, depended upon the character of the man's Wa-zhi*n*', his mind, will-power and energy, or, in other words, his personality.

This estimate of a man's will-power could be traced in other words, customs and ceremonies of the Omahas, and in other tribes belonging to the Siouan group, for this belief was not only connected with sacred rites and social ceremonies, but it was also intermingled with homely customs and offices that were shared in by both old and young. In view of this wealth of testimony from the daily life of these Indians, it is not surprising that the languages of the people should betray the dominance of 'the idea of Personality.'

Alice C. Fletcher.

Peabody Museum,
Cambridge, Mass.

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*THE SAND-PLAINS OF TRURO, WELLFLEET, AND EASTHAM.**

Lower Cape Cod exclusive of Provincetown, or that portion of the Cape comprised within the townships of Truro, Wellfleet, and Eastham, is made up of a succession of sand-plains, of the type so prevalent in eastern Massachusetts. The plains are numerous, nevertheless they can all be referred to three distinct series, differing from each other in elevation and direction of extent. The northernmost of these are the *Truro Plains*, with an average elevation of eighty feet above sea level. These stretch from High Head southward to about half a mile below North Truro village and eastward to Highland Light. Transverse depressions, with a general northeast and southwest trend, separate the individual plains of this series on the west, while depressions with a north and south or a northwest and southeast trend limit them on the east. The slopes bounding these depressions have all the appearance of old constructional slopes, no indications of subsequent erosion having been observed. As an exception to this, however, the slopes bordering Salt Meadow and Moon Pond Meadow on both sides of High Head should be mentioned, these having all the appearance of ancient erosion scarps. The most typical of the northeast and southwest depressions is the one occupied by the road leading from North Truro station to Highland Light. Here the northern slope has all the characters of a southward descending *delta front* of an ordinary sand-plain, while the slope to the south of the road resembles a northward descending *ice-contact* slope. This difference in angle of slope is well shown by the fact that the village of North Truro is built wholly upon the gentler *delta* (?) slope north of the road. This relation of slopes holds for all the northeast and southwest depressions, while in the north and south and in the northwest and southeast depressions the steeper *ice-contact* (?) slope is invariably on the west, and the gentler *delta* (?) slope on the east. Kettle holes are common.

The *Wellfleet Plains* stretch southward from Highland Light to Wellfleet village, with an average elevation of 140 feet above sea level. Highland Light plain is a typical example. For the main part, a depression

* Abstract of a paper read before the Boston Society of Natural History, January 6, 1897.

exists between the Truro and Wellfleet plains, the latter presenting steep *ice-contact* (?) slopes towards the *northwest*.

South of North Truro village, however, the lower plain joins on directly to the higher. Kettle holes are common. Standing upon the high ground a mile north of Truro station and looking east, the whole series of plains seems to descend by a gentle *delta* (?) slope toward the west, leaving a deep and irregular depression occupied by the Provincetown turnpike. In the vicinity of Small's Hill a number of profound northeast and southwest depressions dissect the plain. These are occupied by the roads leading to the east shore. The slopes on both sides of these depressions are steep, and although they probably have been modified by wind the indications are that they are due to former lobes of ice dissecting the growing delta. Pamet River completely divides this series of plains, the southern portion being much more irregular and hummocky than the northern and also containing a number of kettle ponds.

The *Eastham Plains* are typically developed about North Eastham village. This series may be better regarded as one continuous plain uniform along the eastern shore from Wellfleet to the 'Three Lights,' where the elevation is about seventy-five feet above the sea, and the whole plain gently sloping westward. The northern half of this large plain is dissected by discontinuous east and west, and northwest and southeast depressions, with steep *ice-contact* (?) slopes on the south and lobate *delta* (?) slopes on the north. In the southern half of the plain the depressions have a north and south trend, with the steep *ice-contact* (?) slopes on the west and the *delta* (?) slopes on the east. South of Eastham Centre the plain joins on to the moraine. This plain was probably formed while the Truro Plains were accumulating and after the Wellfleet Plains had been formed. The latter seem to have been built by streams from the north and east. The Truro plains were built by streams from the northwest and northeast, while the Eastham Plain was being built by streams from the east. The terminology is applied to the slopes with some reservation, as almost the only criterion by which to judge of their character is the relative steepness and the general outline. Cuttings are very rare, and hence the relative coarseness of the material, and its disposition within the plains cannot be ascertained. The sections along the shore exhibit horizontal stratification where not covered by talus.

It seems difficult to believe that these plains have not accumulated in static water at the front of the much-dissected ice sheet. Submarine accumulation seems improbable, as erosion scarps would have been formed on the higher plains during the formation of the lower. On the other hand, if a body of fresh water was held up against the moraine, in an embayment in the ice front, it would be necessary to suppose that the ice held on to the moraine from Barnstable eastward, and that a residuary plug of ice filled the valley of Buzzard's Bay. This latter necessity is probably the most serious defect of the glacial lake theory.

AMADEUS W. GRABAU.

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### *A NEW METHOD OF DRIVING AN INDUCTION COIL.*

SINCE the induction coil has come into prominence through the discovery of the X-rays of Röntgen considerable attention has been turned toward devising some means which is applicable to long runs, on a voltage such as is furnished by electric light mains, 110 or 220 volts. The more recent forms of break work well with storage batteries, but these are troublesome, and a break which will work satisfactorily on the voltage of ordinary electric-light mains is

yet to be supplied. The following method has been devised to meet these difficulties:

A condenser of considerable capacity is first connected to the lighting mains and charged at 220 volts. It is then disconnected and discharged through the primary coil. The charging and discharging of the condensers is effected by means of a commutator. In this way the only current passing through the coil is from the condenser. The commutator is on the shaft of a small fan motor.

A six-inch Ritchie coil connected in this way with a condenser of 25 microfarads, its own condenser being disconnected, gives a thick fuzzy spark about two inches long. Removing the primary of the coil and replacing it by about seventy turns of rather heavy wire, number 8 or 6 B. & S., we get a multitude of fine zig-zag sparks about six inches long, the discharge being identical in appearance with that from an induction worked in the ordinary manner under the best conditions. The introduction of iron, unless finely laminated, cuts down the discharge to about one-tenth its value. Increasing the speed of the charge and discharge of the condenser up to about 2,000 per minute, which is the limit of the very crude commutator at present employed, improves the discharge of the coil in quantity and voltage. The sparking on the commutator is very slight, and the amount of power taken from the mains is small.

The discharge obtained in this way, so far as we can now judge, seems well suited for driving X-ray tubes. Tubes so driven give a brilliant fluorescent screen with strong sharp shadows. An exposure of twenty seconds gives a good photograph of the hand.

Chas. L. Norton,
Ralph R. Lawrence.

Rogers Laboratory of Physics,
Mass. Institute of Technology,
Boston, February 17, 1897.

## *CURRENT NOTES ON PHYSIOGRAPHY.*

### THE COLORADO PLAINS.

An essay by Gilbert on the 'Underground Water of the Arkansas Valley in Eastern Colorado' (17th Ann. Rep. U. S. Geol. Surv.) affords more specific information as to the topographic features of the plains and their origin than is usually obtainable from older reports. The general surface of the plains does not accord with the surface of their uppermost stratum, but bevels across the strata at a faint angle. The plains are therefore not in topographic youth, but in topographic old age, the result of a cycle of denudation during a lower stand of the land. On the peneplain thus formed there are now strewn the 'upland sands,' pebbly, cross-bedded, 50 to 200 feet thick; the pebbles being derived from the mountains on the west. This implies a period of aggradation, after the long preceding degradation. In explanation of the change it is suggested that the region may have been raised in the east or depressed in the west so as to lessen the slope of the rivers; to this there may be added a possible uplift of the mountains alone by which the load of the rivers would have been increased. To-day the sand-strewn peneplain is trenched by broad valleys, that of the Arkansas being fifteen or more miles wide and 400 to 800 feet deep. Successive pauses in the work of valley-cutting produced broad straths at lower and lower levels, whose remnants are now seen in gravel-covered terraces, the seat of much irrigated land. The eastward slope of the terraces is greater than that of the present grade of the river; hence a progressive uplift is argued during the excavation of the valley. The upland sands and the stream beds at low water supply sand to the northwest winds and extensive patches of dunes are thus formed, a system of hills and hollows without drainage by streams. The relation of Cretaceous strata, upland sands

and dunes to ground and underground water is fully discussed.

THE PREGLACIAL KANAWHA.

THE effect of drift obstructions in altering the courses of rivers in western Pennsylvania and eastern Ohio has been recognized for a number of years, the northward discharge to Lake Erie having been thereby greatly decreased. The diversion of the Missouri from a northward discharge to its present membership in the Mississippi system is also credited to glacial obstruction, and the important service of the great western river as a guide to western exploration, early and late, on our side of the Canadian boundary may, therefore, be credited, along with the water powers of New England, to the glacial period. Still another example of this kind is noted in the 17th Annual Report of the Geological Survey, in which the Director mentions a discovery by F. Leverett, with reference to the ancient drainage of the Virginias. The Kanawha, uniting with other streams in the western part of West Virginia and eastern Kentucky, ran in preglacial time northward towards Lake Erie, along a line partly coincident with the course of the south-flowing Scioto of to-day. This makes the preglacial drainage of the St. Lawrence include headwaters in North Carolina. The existing Ohio can, therefore, no longer be interpretated as of ancient origin, as if still flowing along a consequent course between paleozoic uplifts on the north and southeast. It is a composite stream of postglacial date. As a glacial product, it has been of even greater service than the Missouri, for our early settlers in its fertile lower valley took great advantage of its well-graded course, along which their advance was much easier than if they had had to go up and down hill, across the grain of various north-flowing rivers.*

*Some of my correspondents have pointed out that a suggestion regarding the origin of Teay valley (SCIENCE, II., 1895, 40) independent of the Kanawha, is inadmissible; for the valley contains gravels that could only have come from the upper Kanawha. Its origin by Big Coal river, therefore, seems out of the question.

THE RIVERS OF SAGINAW BAY.

A NUMBER of years ago Gilbert described the course of the Maumee river in northern Ohio, showing that its peculiar back-handed branches were consequent upon the faint relief determined by moraines and glacial lake beaches. A recent essay by Taylor (Correlation of Erie-Huron beaches with outlets and moraines in southeastern Michigan, Bull. Geol. Soc. Amer., VIII., 1897, 31–58) now gives another example of a very similar kind and warrants the recognition of these back-handed branches under some appropriate name, ready for convenient use when still other members of the class shall be discovered. Saginaw river, with its Cass and Tittibawasee arms, and swampy head opposite the upper course of Grand river, repeats the essential features of the Maumee to a nicety.

Back-handed branches resulting from the migration of divides quite independently of glacial constraint are easily distinguished from the class here considered. The barbed arrangement of the upper branches of the Maira recently diverted from the Inn on the watershed of the Alps are of this second class.

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## *CURRENT NOTES ON METEOROLOGY.*

CHALK-PLATE WEATHER MAPS.

ONE of the recent improvements in the methods used by our Weather Bureau deserves mention in these Notes. As is generally known, the daily weather maps issued from the various Weather Bureau stations over the country have for some years been reproduced by a stencil process which, although a good method, when carefully ex-

ecuted, for a limited number of maps, becomes inadequate when several hundred copies have to be struck off. As a result of experiments, Mr. J. W. Smith, local forecast official of the Weather Bureau at Boston, Mass., suggested what is known as the chalk-plate printing process. It is as follows: A thin covering of specially prepared chalk ($\frac{1}{8}$ in. in thickness) is spread upon a steel plate of the size of the prospective weather map. On this chalk are engraved, by means of suitable instruments, the various weather symbols, the isobaric and isothermal lines, etc. The plate is then stereotyped in the ordinary way. In addition to the weather map proper, there is, of course, a considerable amount of printed matter, such as the forecast, summary, the table of instrumental readings, etc. This textual portion is made up by the use of logotypes, consisting of words, figures and phrases in which the different letters and figures are joined together in one solid piece of type to facilitate the work of setting up. Thus, when the word 'fair' or 'cloudy' has to be used, it is not necessary to set up the individual letters forming the word, but only to select the logotype which prints the word. After the text of the map is set up in logotypes, it is locked up with the stereotype map plate, and the whole is printed at one impression on a sheet prepared for the purpose, which has a blank outline map of the United States at the top, on which the weather map is printed, and space in the lower half of the sheet for the text and tables. The chalk-plate process map is in every way a great improvement on the stencil map which it has superseded. It is smaller, more convenient to handle, more legible and more attractive. A minute study of our daily weather maps is now a distinct pleasure, whereas formerly it was often a difficult task to attempt to puzzle out the faint lines, words and figures, which were too frequently barely legible. The size of the chalk-plate map itself is $10 \times 6\frac{1}{2}$ inches, and of the whole sheet, which includes also the text and tables, $16 \times 11$ inches. The first map made by this process issued from any Weather Bureau station was sent out from Boston on February 29, 1896. Since then the system has been extended as rapidly as possible to the other stations, and at the present time 21 stations issue chalk-plate maps. These are as follows: Boston, Mass.; Cleveland and Columbus, O.; Indianapolis, Ind.; Raleigh, N. C.; Nashville, Tenn.; Chicago, Ill.; Baltimore, Md.; Philadelphia, Pa.; New York and Buffalo, N. Y.; Milwaukee, Wis.; Galveston, Tex.; Louisville, Ky.; Little Rock, Ark.; Montgomery, Ala.; New Orleans, La.; Denver, Colo.; Lincoln, Neb.; Minneapolis, Minn.

PRIZES FOR SCHOOL WORK IN METEOROLOGY.

It is worthy of note in these columns that a definite step has been taken towards encouraging and systematizing school work in meteorology in the New England States. On the dissolution of the New England Meteorological Society, in 1896, a sum of money was left in the hands of a committee, to be used 'for some meteorological purposes.' The committee now offers three annual prizes, of twelve, ten and eight dollars, for the best work on weather and climate in any New England school below the high school, under certain conditions. The papers and record books sent in, in competition for the prizes, are to be wholly the work of the pupils whose names they bear, and all records are to be the result of the pupils' own observations. The committee suggests the following topics as appropriate subjects for such work: (1) Observation and record of simple weather elements. (2) Preparation of weather maps based on data supplied by the teacher. (3) The use of weather maps and of local observations in simple weather predictions. (4) Special observation and study of the elements that control the cli-

mate of New England. A circular giving full details has been issued, and may be procured from the undersigned.

SOME INTERESTING REPRINTS.

PROFESSOR HELLMANN, of Berlin, has recently issued three more of his *Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus*. These are: No. 7. EVANGELISTA TORRICELLI: *Esperienza dell 'Argento Vivo*. ACCADEMIA DEL CIMENTO: *Istrumenti per conoscer l'Alterazioni dell 'Aria*, containing the most important papers relating to the discovery of the barometer, thermometer and hygrometer, some of them in facsimile. No. 8. HALLEY, VON HUMBOLDT, LOOMIS, LEVERRIER and RENOU, *Meteorologische Karten*, being the earliest synoptic weather charts with wind, isotherms and isobars drawn between 1688 and 1864. No. 9. HENRY GELLIBRAND: *A Discourse Mathematical on the Variation of the Magnetical Needle*, containing the discovery of the secular variation of magnetic declination. This is a facsimile of the very rare work published in London in 1635. A few copies of these pamphlets may be had of A. L. Rotch, Blue Hill Observatory, Readville, Mass., at the publisher's price of 3 marks, or 75 cents each, postpaid.

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## *CURRENT NOTES ON ANTHROPOLOGY.*

THE AGE OF MAN.

IN his recently published 'Handbuch der Palæontologie,' Professor Zittel, of Munich, reviews the alleged instances of the discovery of human remains in strata older than the alluvial period. His general conclusion is that "prehistoric researches do not yield positive information or definite results as to the antiquity of the human species." He follows Virchow in rejecting the high antiquity of the Neanderthal skull and denies that any discovery of glacial man in America has yet been made. He accepts, however, as probably 'fossil or quaternary,' the skull of Eguisheim, the jaw of Naulette and that of the Schipka cave, and the skull of Olmo in Tuscany.

Professor Morselli, who reviews Zittel's conclusions in the 'Archivio per l'Antropologia,' doubts the skull of Olmo, but argues that Zittel is generally too sceptical. He also adds the statement that the fossil human skeleton from the Pampean formation of the Argentine Republic, said by Zittel to be in the Museum of Milan, is not there.

ON SMALL CHIPPED FLINTS.

THERE is a class of small chipped flint objects, with a general similarity of shape and finish, found in England, France, Egypt, India, North Africa and elsewhere. In the *Revue de l'Ecole d'Anthropologie* for November, A. de Mortillet offers a careful study of their forms, geographical distribution, use and antiquity.

They are generally rudely triangular, rhomboidal, or like the segment of a circle. One edge is neatly dressed with secondary chipping, while another is left with the natural cleavage. The length varies from 15 to 35 millimeters. They may have been used as arrow points, as scarificators, as tools, or, in some instances, as fish hooks. In age, they appear to belong to the earliest neolithic period. Their singular similarity does not entail the proof of transmission, but rather of independent development.

While in America there are many specimens generally akin to these described by Mortillet, they cannot be said to represent any distinct culture area or period.

D. G. BRINTON.

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## *SCIENTIFIC NOTES AND NEWS.*

DR. THOMAS M. DROWN, President of Lehigh University, has been elected President of the American Institute of Mining Engineers.

THE students of the Massachusetts Institute

of Techology will place, as a memorial, a bust of the late President Walker in the corridor of the Rogers Building. The memorial will be designed by Mr. D. C. French.

At the regular January meeting of the Regents of the Smithsonian Institution, Mr. Charles D. Walcott was, as already noted, appointed Assistant Secretary of the Institution, and placed in charge of the U. S. National Museum, his official designation being 'Acting Assistant Secretary in Charge of the National Museum.' At an adjourned meeting of the Regents, Mr. Richard Rathbun was appointed Assistant Secretary 'with duties connected with the bureaus of the institution other than the National Museum,' and was placed in charge of the office and exchanges. By these appointments the position and duties of the late Dr. Goode are divided between two officials, of whom the last appointed performs certain additional duties.

It is stated in *Nature* that Lady Prestwich is collecting material for a biography of the late Sir Joseph Prestwich, and will be grateful to friends if they will forward to her any letters they possess, addressing to Shoreham, near Sevenoaks. They will be at once copied and carefully returned.

One of the silver medals of the Veitch memorial fund of London has been awarded to Professor L. H. Bailey for distinguished services to horticulture.

The Chanute prize of $100 for the best monograph on kites has been awarded by the Aeronautical Society to Professor C. F. Marvin, of the United States Weather Bureau.

The Royal Society of New South Wales has awarded its bronze medal and a money prize of £25 to J. Milne Curran for a paper on the occurrence of precious stones in New South Wales, with a description of the deposits in which they are found.

The University of Cambridge will confer the degree of LL. D. on Dr. Fridjof Nansen.

Dr. Julian Aparicio has been appointed Director of the Meteorological and Astronomical Observatory of San Salvador in the room of the late Dr. Don Alberto Sanchez.

Professor J. Franz, astronomer at the Königsberg Observatory, has been appointed Director of the Observatory at Breslau and professor at the University in the place of Professor T. Galle, who has retired.

Dr. F. Folli has retired from the Directorship of the Royal Observatory, Brussels.

M. Jean Perrin has been nominated by the Paris Academy of Sciences to the Joule Scholarship of the Royal Society, which is awarded alternately in England and in other countries.

We regret to record the deaths of Professor W. Wallace, professor of moral philosophy in the University of Oxford, who was killed on February 19th by a fall from a bicycle, and of Professor Charles Tomlinson, F. R. S., a writer and lecturer on scientific subjects, who died at Highgate, England, on February 15th.

Professor A von Kölliker, professor of anatomy in the University of Würzburg, will celebrate his eightieth birthday and the fifteenth anniversary of the commencement of his career of a teacher on July 6th.

Among the lectures given at the Royal Institution, London, during the present month were the following: February 11th, Dr. J. W. Gregory, of the British Museum (Natural History), the first of a course of three lectures on 'The Problems of Arctic Geology.' Friday evening discourse, February 12th, by Professor John Milne, F. R. S., on 'Recent Advances in Seismology.' February 19th, Mr. G. Johnstone Stoney, on 'The approaching return of the great swarm of November Meteors.'

Professor J. J. Stevenson, President of the New York Academy of Sciences, will give a public lecture before the Academy at Columbia University this evening. The subject is 'A Talk on Coal,' and the lecture will be illustrated.

The department of paleontology of the University of Kansas will send to the coming international exposition at Brussels copies of large restorations of seven extinct animals, based upon the material in the museum and prepared by or under the direction of Dr. Williston.

We learn from *Nature* that a German antarctic meteorological station will be established

shortly in Victoria Land, under the direction of Dr. Rudolph Mewes. The station will be in connection with the German South Polar expedition, and will have for its object the determination of meteorological conditions during the anarctic winter.

THE library of the late Professor du Bois-Reymond is offered for sale by Gustav Fock, Leipzig. It contains 14,000 books and pamphlets, including many valuable sets of periodicals. The heirs wish it to be sold as a unit and offer it for 22,000 Marks. It would be an unusually desirable acquisition for an American university library.

IT is reported that Mme. Larapidie has given money for a meteorological and astronomical observatory and a museum at Jerusalem.

THE Academy of Sciences of Vienna has sent to Bombay a commission, composed of Dr. Hermann Müller, Dr. Ghon, Dr. Albrecht and Dr. Pöch, to investigate the nature of the plague. The expenses are defrayed by the Treitl fund, left to the Academy by the late Herr Treitl, and amounting to $500,000.

A BILL has been introduced into the New York Legislature, authorizing New York City to spend $2,500,000 in the erection of a library building on the site of the reservoir adjoining Bryant Square. The income of the Astor, Lennox and Tilden foundations is about $160,000 annually, and if the building were provided this would be sufficient to maintain an adequate reference and circulating library in New York City.

THE fourth Annual Exhibit and Reception of the New York Academy of Sciences will be held at the American Museum of Natural History on Monday and Tuesday, April 5th and 6th, and will be open from eight to ten in the evening, and on April 6th from three to five in the afternoon. Arrangements are in progress for having a demonstration and lecture of about half an hour in length in the lecture hall each evening. Exhibits of newly invented apparatus will be welcomed from men of science, not resident in New York, who should address the Chairman of the Committee of Arrangements, Professor R. E. Dodge, Teachers' College, New York.

THE second annual convention of the American Association of Manufacturers met at Philadelphia on January 26th, 27th and 28th. The membership of this Association has during the past year increased from 300 to 900 and the revenue for the year amounted to $40,000. The Association has sent commissions to South America, Mexico and Japan to study manufactures and commerce, and the reports of these commissions and the results of the discussions on these and other subjects have a certain amount of scientific interest. It was recommended that a Department of Commerce and Manufacture be established under the government and that the consular service be placed under this proposed department.

As we reported sometime since, the sum of $60,000 left by the late Sir William Macleay, for the establishment of a lectureship in bacteriology in Sydney, was not accepted by the University, and reverted to the Linnean Society of New South Wales. The Society is now prepared to equip a laboratory and wishes to receive applications for the lectureship, the duties of which are chiefly research. The salary is £350.

D. APPLETON & Co. announce for early publication 'Pioneers of Evolution,' from Thales to Huxley, by Edward Clodd; 'The Aurora Borealis,' by Alfred Angot; and new editions of 'Dynamic Sociology,' by Professor Lester F. Ward, and 'Sight,' by Professor Joseph LeConte.

DR. JOHN W. HARSHBERGER, of the University of Pennsylvania, has now in manuscript a book entitled 'The Botanists of Philadelphia and their Work.' It will contain about 500 pages of printed matter and 50 full-page plates.

THE British Balneological and Climatological Society has published the first number of a new quarterly journal edited by Dr. Samuel Clyde, Chairman of the Council of the Society.

THE Foreign Affairs Committee of the House of Representatives will report favorably a bill for the reorganization of the Consular service. According to this bill a commission would be appointed by the President which would reorganize the service by a system of civil service examinations for admission, the abolition of the fee system and the rating of Consular offices in grades at stated salaries and tenure of office

during good behavior, with removals only by the action of a board after a trial on charges. A reform in the American Consular service might contribute to scientific progress, as it certainly would to economic and commercial interests. It is doubtful whether United States Consuls would be competent to write reports such as those of the British Consuls on the advantages of the metric system published in the last number of this JOURNAL.

KÖLLIKER'S well-known and esteemed shorter treatise on embryology entitled 'Grundriss der Entwickelungsgeschichte' is now being reissued. The preparation of the new edition (the third) has been entrusted to Professor Oscar Schultze. The first part has been issued by Engelmann, at Leipzig, and follows closely in typography and so forth the previous editions, which means that the illustrations are superior to what is usual in American and English scientific books. The present part deals with the early stages, the development of the external form and the fœtal envelopes and placenta. The scope of the text has been extended so as to make the book really a manual of mammalian embryology, and this has involved rewriting so extensive that we have practically a new work. It is one of very great merit; the difficult descriptions are both clear and concise, and the author displays a broad and accurate knowledge of his subject. We hope to give a fuller notice of the work upon its completion.

UP to February 18th the returns of the health authorities of the plague report that since its outbreak there have been 6,853 cases and 5,447 deaths from the disease in Bombay, and in the entire Presidency 9,911 cases and 8,006 deaths. The mortality attributed to other sources has also been excessive. 75 per cent. of the inhabitants have left Bombay. The conference on the plague now meeting in Venice has been divided into two bodies, but details regarding its work are lacking. It may, however, be well to quote from the *Times* some facts regarding this and preceding conferences: It will be practically the fourth of a series of international sanitary conferences, and will, it is expected, complete a system of efficacious measures for the prevention of the spread of epidemics. Now, as in the three preceding instances, the initiative is due to Austria-Hungary and has been taken exclusively for the general welfare. The upshot of the first sanitary conference, held at Venice in 1891, was to close the door in Egypt to the spread of epidemics to Europe. The result of the second conference, which was held at Dresden in 1893, was to adopt a maximum of protection accomplished by a minumum of hindrances to international traffic. On the basis of the Dresden Conference almost all the Powers concluded territorial conventions with their neighbors on very broad lines. The third conference, which met in Paris in 1894, supplemented the work of the two previous conferences with regard to the pilgrimages from India to the sanctuaries of the Sunnite Mahomedans at Mecca and Medina.

AN editorial article in the current number of the *Journal of Geology* recommends that the winter meetings of the Geological Society of America be held regularly in Washington. It is argued that the success of the recent meeting of the Geological Society was undoubtedly due to the fact that it was held in Washington. No other city in the country offers so many attractions to geologists in the winter time as the National capital. Containing, as it does, the largest body of geological investigators to be found in any one place in the world, it has become a center of geological activity and the repository of many valuable collections. Located within easy reach of the universities of the East and South and of the Middle West, it has become a favorite rendezvous for geologists scattered throughout these parts of the country. For these reasons the writer of the article holds that the suggestians made by Mr. Walcott, Director of the U. S. Geological Survey, that the Society hold all its winter meetings in Washington and its summer meetings elsewhere is an excellent one. It was heartily endorsed by the retiring President, Professor Le Conte.

DR. R. ELLSWORTH CALL has directed our attention to a report in the Indianapolis *Journal* of perhaps the most extraordinary piece of legislation ever undertaken. A bill has been passed by the Indiana Legislature, part of which reads as follows:

"It is impossible to compute the area of a circle on the diameter as the linear unit without trespassing upon the area outside of the circle to the extent of including one-fifth more area than is contained within the circle's circumference, because the square on the diameter produces the side of a square which equals nine when the arc of ninety degrees equals eight. By taking the quadrant of the circle's circumference for the linear unit we fulfill the requirements of both quadrature and rectification of the circle's circumference. Furthermore, it has revealed the ratio of the chord and arc of ninety degrees, which is as seven to eight, and also the ratio of the diagonal and one side of a square, which is as ten to seven, disclosing the fourth important fact, that the ratio of the diameter and circumference is as five-fourths to four, and because of these facts and the further fact that the rule in present use fails to work both ways mathematically it should be discarded as wholly wanting and misleading in its practical applications. * * * And be it remembered that these noted problems had been long since given up by scientific bodies as unsolvable mysteries and above man's ability to comprehend."

WE have received from the Australian Museum at Sydney, N. S. W., a memoir which is the first of a series giving an account of the Atoll of Funafuti by Mr. Charles Hedley, conchologist. We learn from an introductory note by the curator, Mr. R. Etheridge, Jr., that the local committee of the Funafuti Coral Reef Boring Expedition, of the Royal Society, in charge of Professor Sollas, having suggested to the Trustees of the Australian Museum that one of their officers should be deputed to accompany the expedition, Mr. Charles Hedley was selected for the purpose. Mr. Hedley left Sydney in H. M. S. 'Penguin,' under the command of Captain Mervyn Field, R. N., on May 1st, arriving at Funafuti on May 21st. He remained on the island for two and a half months, leaving in the same vessel. On the return voyage to Fiji, the Island of Nukulailai was touched at, where scientific investigations were renewed for two days. Mr. Hedley finally reached Sydney on August 22d. During his stay on Funafuti, Mr. Hedley succeeded in amassing an interesting collection, particularly of invertebrate and ethnological objects, together with much valuable scientific information. The collections are now in process of description by the Scientific Staff of the Museum, and the results are being published in the order in which the study of the various groups is completed.

## *UNIVERSITY AND EDUCATIONAL NEWS.*

THE late Mr. William Lampson, of LeRoy, New York, has bequeathed his fortune, with the exception of a few small bequests, to Yale University. The bequest is said to amount to about $500,000. $150,000 is to be used for an auditorium and the rest for the endowment of professorships.

THE Stevens Institute of Technology, celebrated the 25th anniversary of its foundation on February 18th and 19th. There was a dinner at the Hotel Waldorf, a reception by Mrs. E. A. Stevens and a meeting at which addresses were made by Bishop Potter and President Morton, who described the achievements of the institution, its present condition and its future aims. Mr. Dod read a letter from President Morton, in which the President gave 1,000 shares of stock of the Texas Pacific Railroad to the board of trustees, 'to be held until their appreciated value with such other funds as may be devoted to the purpose, may be adequate for the erection and maintenance of the proposed new building generally referred to as the alumni building.'

THE Marquis of Bute, the present Lord Rector of the University of St. Andrews, will erect for the University four laboratories, including lecture rooms and museums, for the departments of anatomy, physiology, materia medica and botany.

MISS UMPHERSTON has been appointed lecturer in physiology at St. Andrews University.

## *DISCUSSION AND CORRESPONDENCE.*

### 'THE ARGENTAURUM PAPERS.'

TO THE EDITOR OF SCIENCE: I think I ought not to pass unnoticed a statement and an unauthorized use of my name, made by Mr. S. H. Emmens in an advertisement just published in SCIENCE. He says: "The author has received many communications from eminent authorities explicitly approving of his work; while others have written in such a manner as to show that

they regard his arguments and mathematical demonstrations as incapable of refutation. Among these authorities may be named the following:" In the list of names there given my own appears.

The fact is that I regard the points he attacks as being beyond debate, and simply decline to discuss the matter with him, telling him as plainly as the forms of courtesy permit, that I consider his work of no value. I know personally that substantially the same is true of at least two others whose names are on the list, and have no doubt it is true of all. Comment is unnecessary.

C. A. Young.

February 20, 1897.

[The responsible editor of this Journal did not know of the insertion of the advertisement claiming the endorsement by Professor Young and others of Mr. Emmens' absurd book. He has written to the Macmillan Co. requesting that no further advertisement of the book be inserted. Ed.]

## Former Extension of Greenland Glaciers.

I should be exceedingly sorry to misstate the views of a fellow worker, as Professor Chamberlin* infers that I have done, from a a short abstract† of a recent paper read before the Geological Society of America, but not yet published. His editorial places quite a different interpretation upon his views from that which I had gained from a reading of his articles. After a journey of a thousand miles along the Greenland coast, he says:‡ "The inference was drawn that the ice formerly so extended itself as to reach the present coast over about half of its extent, while in the remaining portion the ice fell short." Professor Salisbury§ states that the phenomena indicate that the ice has not recently overridden the 'islands of the coast of Greenland,' and moreover that it is a question if this is a possibility.

In his editorial Professor Chamberlin states: "In its bearings upon these general problems, an advance of a few miles, more or less, an ineffectual overtopping of a few heights, more or less, are relatively inconsequential. Our language is to be interpreted in the light of the major question whose solution we sought." These 'major questions' are: (1) whether the Greenland ice was the source of the American ice sheet, which I did not suppose that anyone seriously believed at present; and (2) whether the Greenland ice ever reached 'out into the heart of Baffin's Bay.'

It would not be profitable to restate any of the arguments in my paper, which is soon to be published; but if this proves what it attempts to prove, namely, that angular peaks have been glaciated, and yet have remained angular, largely because they projected *into* the ice, and that, in one place, in spite of rugged, unsubdued peaks, there is perfect evidence that the ice reached beyond the present land margin, it must overthrow any conclusion concerning former ice extension that is based upon angular topography alone.

A careful detailed study of a single region proves that a land of rugged peaks has been glaciated. Is it then a safe conclusion to draw that the 'ice fell short' o l f the coast, upon the basis of evidence from angular topography, mainly seen from a ship from five to twenty miles distant? I would go further and ask if, upon such evidence, the conclusion is warranted that the ice did not extend 'out into the heart of Baffin's Bay?' Personally, I draw no conclusion concerning how much of the Greenland coast has been glaciated, nor how far the ice extended; but I do know that ice can override peaks for a long enough time to scour valleys and hillslopes well, and yet leave the peaks rugged and angular in outline; and I also know that the ice in the Upper Nugsuak peninsula region once reached 30 or 35 miles beyond its present margin, which is as far as any evidence can be found in this region. For the larger question, how far it extended, and how much coast it covered, I believe it is well to wait until further evidence is at hand.

Ralph S. Tarr.

* Editorial, Journ. Geol., V., 1897, 81.

† Journ. Geol., V., 1897, 95.

‡ Bull. Geol. Soc. Am., 1895, VI., 219.

§ Jour. Geol., IV., 1896, 774.

## Compliment or Plagiarism.

The second carefully prepared plea of Professors Beman and Smith is simply a conscious

dodging. The case against them is very plain and may be put thus: I offer to pay a year's subscription to SCIENCE for any man, woman or child who will inform the editor of any book in any language where can be found a Section, Partition of a Perigon, or, as Beman and Smith reprint it, Partition of *the* Perigon, and the problems: Problem I., to bisect a perigon; problem II., to trisect a perigon; problem III., to cut (divide) a perigon into five equal parts (angles); problem IV., to cut (divide) a perigon into fifteen equal parts (angles), excepting Halsted's Elements (1885) and Beman and Smith (1895). The question about the word perigon is an issue introduced by Beman and Smith to distract attention from their '*take*.'

But their laborious researches on this matter turn out highly complimentary to me. They find that not a single geometry can be found in any language that ever used this word until after mine. They find, by actual laborious correspondence that W. B. Smith, Newcomb, and even the Italian Faifofer, saw the word for the first time in Halsted's books.

They say, SCIENCE, p. 275: "*We have reason to believe that W. B. Smith, Newcomb and Faifofer all did see the word for the first time in Halsted's books.*" This is all that I have ever claimed about this word, and surely it does me great honor. As to whether I first coined this word, I gave the facts to Cajori (see his 'The Teaching and History of Mathematics in the United States,' 1890, p. 237); but the question for Beman and Smith is whether, like the other geometers, they first saw the word in the only place where any man, before their plagiarism, ever saw the phrase Partition of a Perigon.

GEORGE BRUCE HALSTED.

## THE NATIONAL UNIVERSITY: A SUGGESTION.

ON the birthday of Washington this year it has been proposed to bring before as many persons as possible the thought of a National University, with portions of Washington's addresses to Congress, and the clause of his will relating to the subject, in order, to use his own words, 'to set the people ruminating on the importance of the measure as the most likely means of bringing it to pass.'

Relatively few people know that in this document the far-sighted man whom we love to call the Father of his Country bequeathed to the Nation the equivalent of $25,000, in trust as the nucleus for the endowment of such an institution. To-day such an endowment would appear small, but neither principle nor earnings of this sum have ever been applied to the purpose for which it was intended, and had it been kept invested at six per cent. during the century that has all but passed since the testator's death this modest gift would be worth to-day over $12,000,000.

Some sentiment is, no doubt, behind the earnest movement that is now making toward the realization of Washington's hopes, and popular sentiment in a popularly governed country is far from powerless. But the establishment of an educational institution, especially of a university in the proper sense, and above all of a university which is expected to be in fact as well as in name a National University, should depend upon more than popular feeling that the hopes of the broad-minded Washington deserve, even at this late day, to be realized.

When these hopes were formed the country had, in fact, not one university which to-day could justify its use of the name. To-day, among the hundreds of nominal universities, there are scores which offer post-graduate facilities in one or more departments sufficient to justify them in offering advanced degrees, and a few possess an equipment for work whereby the doctor's degree may be earned in either of the principal departments recognized as necessary or desirable for post-graduate work, or university work as contrasted with that which is purely collegiate. Surely these institutions may properly lay claim to the name of university.

Yet, if we possess universities worthy of the name, can it be urged that these are sufficiently numerous, or even sufficiently strong individually, to preclude the desirability of adding to their number one which may hope to do in its every department work equal to that done in the best departments of the best existing institutions? The president* of one of the most

*Jordan, The urgent need of a National University. The Forum, 22: 600, January, 1897.

amply endowed of our colleges does not hesitate to declare for the advisability of the proposed action. He opens his appeal with the statement that 'the most important event in the history of modern Germany has been the foundation of the University of Berlin'—its National University; and he even tells us that the place at the head of our own American educational system is now held by the universities of a foreign land.

True it is that the real scholar who has earned his baccalaureate degree turns to a stronger center than his alma mater, if possible, when he enters upon the struggle for the doctorate; and having taken this, if he deserve it he may sometimes hope for a fellowship from the university that has stamped its official seal on him as a scholar and an investigator, which enables him to pursue his studies still further—not at home, but in foreign universities.

Doubtless, this will always be so. Men, if suitably supported, and not places, make universities; and, with all respect for the learned men who compose the faculty of the Berlin University, it may be said that even the graduate of that great institution finds profit in traveling elsewhere, for help and skill not to be found in Berlin. The practical question is: Are Americans in search of opportunity for advanced study which is not afforded by our existing universities? Are these not increasing in efficiency and capacity in proportion to the growing demand for the best that they can offer? Are there local obstacles in the way of their fullest utilization? Will a National University attract men who need some special inducement to advanced study not now offered? And can it be made to replace the foreign university as the Mecca of our graduate students? Let the university catalogues themselves and the annually collected government statistics answer this in part, nor fear, as some do, that petty ambition and petty jealousy can bias the utterances, on this point, of the officers of any university worthy of the name. Yet, it may well be asked, whatever the answer, who can venture to say that the opening of a National University may not in some real, if not clearly definable, manner appeal to enough men who now stop at the completion of a collegiate course, to justify in the most satisfactory manner its establishment?

If, in my own mind, after trying to view the question impartially, I am not perfectly convinced that there is a real need for a National University, as a center of advanced instruction, I must admit that there may be other more cogent reasons for the attempt now being made to carry Washington's idea into effect; and if, as I cannot help believing, the reasons that influenced his judgment are less weighty to-day than they were a century ago, other reasons, not then revealed, may, perhaps, stand out to-day with greater force than the original reasons ever possessed.

Frequent comment is made, in the scientific press of other nations, on the wonderful liberality of the American government in supporting scientific investigation of our great natural resources. No branch of applied science, or science capable of economic application, is without representation under government auspices. It has been shown recently that no less than 5,225 persons are employed on this scientific and economical work, on which is expended annually nearly $8,000,000.

For some years observing and thinking persons have realized that, great as the value of this work is, it is carried on in too irresponsible and disjointed a fashion to permit of the realization of the greatest possible results, and several more or less successful attempts have been made to secure its partial unification. Quite recently one well fitted to grasp and analyze the situation* has distinctly stated that the time has now arrived when the successful prosecution of the scientific work of the government requires that the various bureaus should be organized in accordance with a logical plan, either under one of the existing governmental departments or in a new department, under the direction of one secretary or executive head.

The scientific bureaus now constitute true university departments in this fundamental respect that they are primarily and preeminently centers of research, manned by investigators.

* Dabney, A national department of science necessary for the coordination of the scientific work of the United States government. Science N. S. 5: 73, 15 January, 1897.

Nowhere else in the country are men as free to delve into the unsolved mysteries and work out the practical application of discoveries as here. If, as President Jordan asserts,* and as, I think, no one will deny, "The National University should not be an institution of general education, with its rules and regulations, college classes, good-fellowship, and football team; it should be the place for the training of investigators and men of action," can a more favorable plan be formulated, for at once realizing the popular idea of a truly National University and meeting the need for a reorganization and centralization of the National Scientific Departments, than to reorganize the latter as the former, charged with the twofold duty of prosecuting all needful investigation and of training all competent students desirous of devoting their lives to a like purpose? To this scientific foundation, history, literature and the arts would be readily added, without wasteful duplication.

WILLIAM TRELEASE.

## SCIENTIFIC LITERATURE.

*Die Spiele der Thiere.* By KARL GROOS, Professor of Philosophy in the University of Giessen. Jena, Gustav Fischer. 1896. Pp. xvi +359.

In this volume Professor Groos makes a contribution to three distinct but cognate departments of enquiry: philosophical biology, animal psychology, and the genetic study of art. Those who have followed the beginnings of enquiry into the nature and functions of play in the animal world and in children will see at once how much light is to be expected from a thorough-going examination of all the facts and observations recorded in the literature of animal life. This sort of examination Professor Groos makes with great care and thoroughness, and the result is a book which, in my opinion, is destined to have wide influence in all these departments of enquiry.

I cannot take space for a detailed report of Professor Groos' positions. It may be well, therefore, before speaking of certain conclusions which are to me of especial interest, to give a résumé of the contents of the book by chapters. Chapter I. is an examination of Mr. Spencer's 'surplus energy' theory of Play; the result of which is, it seems, to put this theory permanently out of court. The author's main contention is that play, so far from being 'by-play,' if I may so speak, is a matter of serious business to the creature. Play is a veritable instinct, true to the canons of instinctive action. This view is expanded in Chapter II., where we find a fine treatment in detail of such interesting topics as imitation in its relation to play, the inheritance of acquired characters apropos of the rise of instincts, the place and function of intelligence in the origin of these primary animal activities. This chapter, dealing with the biological theory of play, is correlated with Chapter V., later on in the book, in which the 'Psychology of Animal Play' is treated. Together they furnish the philosophical and theoretical basis of the book, as the chapters in between furnish the detailed data of fact. I shall return to the biological matter below. Chapters III. and IV. go into the actual 'Plays of Animals' with a wealth of detail, richness of literary information and soundness of critical interpretation, which are most heartily to be commended. Indeed, the fact that the first book on this subject is, at the same time, one of such unusual value, both as science and as theory, should be a matter of congratulation to workers in biology and in psychology. The collected cases, the classification of animal plays, as well as the setting of interpretation in which Professor Groos has placed them—all are likely to remain, I think, as a piece of pioneer work of excellent quality in a new but most important field of enquiry.

As to the plays which animals indulge in, Professor Groos classifies them as follows: 'Experimenting,' 'Plays of Movement,' 'Play-Hunting' ('with real living booty,' 'with play living booty,' 'with inanimate play booty'), 'Play-fighting' ('teasing, scuffling among young animals,' 'play-fighting among adult animals'), so-called 'Building Art,' 'Nursing' plays, Imitation' plays, 'Curiosity,' 'Pairing' plays, 'Courting by Means of Play of Movements,' 'Courting by the Exhibition of Colors and Forms,' 'Courting by Noises and Tones,' 'Coquetry on the part of the Female.'

*l. c.* 603.

With this general and inadequate notice of the divisions and scope of the book, I may throw together in a few sentences the main theoretical positions to which the author's study brings him. He holds play to be an instinct developed by natural selection (for he does not accept the inheritance of acquired characters), and to be on a level exactly with the other instincts which are developed for their utility. It is very near, in its origin and function, to the instinct of imitation, but yet they are distinct (a word more below on the relation between play and imitation). Its utility is, in the main, two-fold: First, it enables the young animal to exercise himself beforehand in the strenuous and necessary functions of its life and so to be ready for their onset; and second, it enables the animal by a general instinct to do many things in a playful way, and so to learn for itself much that would otherwise have to be inherited in the form of special instincts; this puts a premium on intelligence, which thus comes to replace instinct (65f.). Either of these utilities, Professor Groos thinks, would insure and justify the play instinct; so important are they that he suggests that the real meaning of infancy is that there may be time for play.*

It is especially in connection with this latter function of play that the instinct to imitate comes in to aid it. Imitation is a real instinct, but it is not always playful; play is a real instinct, but it is not always imitative. Professor Groos does not suggest, I think, closer relations between these two instincts. There is likely, however, to be a great deal of imitation in play, since the occasion on which a particular play instinct develops is often that which also develops the imitative tendency as well, *i. e.*, the actual sight or hearing of the acts and sounds of other animals. Moreover, the acquisition of a muscular or vocal action through imitation makes it possible to repeat the same action afterwards in play.

It is only a step, therefore, to find that imitation, as an instinct, has to have ascribed to it, in a measure, the same race utility as play—that of going before the intelligence and preparing the way for it, by rendering a great number of specialized instincts unnecessary. It is interesting to contrast this view with that which the present writer has recently developed in these pages (SCIENCE, March 20, 1896), *i. e.*, the view that imitation supplements inadequate congenital variations in the direction of an instinct and so, by keeping the creature alive, sets the trend of further variations in the same direction until the instinct is fully organized and congenital. If both these two views be true, as there seems reason to believe, then imitation holds a remarkable position in relation to intelligence and instinct. It stands midway between them and aids them both. In some functions it keeps the performance going, and so allows of its perfection as an instinct; in others it puts a stress on intelligence, and so allows the instinct to fall away if it have no independent utility in addition to that served by intelligence.* In other words, it is through imitation that instincts both arise and decay—that is, some instincts are furthered and some suppressed, by imitation. And all this is accomplished with no appeal to the inheritance of acquired characters, Professor Groos agreeing with Weismann that the operation of natural selection as generally recognized is sufficient.

The difficulty which I see to this conception of play as a pure instinct is that which is sometimes urged also against considering imitation an instinct, *i. e.*, that it has no definite motor coordinations, but has all the variety which the different play forms show. If the definite congenital plays are considered each for itself, then we have a great many instincts, instead of a general play instinct. But that will not do, for it is one of Professor Groos' main contentions, in the chapter on the psychology of animal plays, that they have a common general char-

* "Die Thiere spielen nicht weil sie jung sind, sondern sie haben eine Jugend, weil sie spielen müssen" (68). Other capital utilities which might be added are (1) the exercise of the intelligence itself and (2) direct *social* utility as such.

* In a private communication Professor Groos suggests to me that the two views might be held to supplement each other. The case is very much like that of early intelligence, in the form of association; where it fully accomplishes the utility also subserved by an instinct, it tends to supersede the instinct; otherwise, it tends to the development of the instinct (Groos, p. 64).

acter which distinguishes them from other specialized instinctive actions. They are distinguished as play actions, not simply as actions. This difficulty really touches the kernel of the matter, and serves to raise the question of the relation of imitation to play; for imitation presents exactly the same conditions—a general instinct to imitate, which is not exhausted in the particular actions which are performed by the imitation. I shall remark on the solution of it below, in speaking of Professor Groos' psychology of play. It will be interesting to see how he treats this problem in his promised work on the *Spiele der Menschen;* for the imitative element is very marked in children's plays.

Other points of great interest in this biological part are the great emphasis which Groos finds it necessary to put on 'tradition,' instruction, imitation, etc., in young animals, even in enabling them to come into possession of their natural instincts; in this the book tends in the same direction as the new volume of Professor C. Lloyd Morgan. Again, there is a remarkably acute discussion of Darwin's Sexual Selection, which the author finally accepts in a modified form by saying that the female's selection is not necessarily conscious, but that she has an inherited susceptibility to certain stimulating colors, movements, etc., in the male. It is not so much intelligence on her part as increased irritability in the presence of certain visual and other stimulations. *Over against the charms of the male he sets the reserve or reluctance (*Sprödigkeit*) of the female, which has to be overcome and which is an important check and regulator at the mating time. Again, the imperfect character of most instincts is emphasized, and the interaction with imitation and intelligence. He finds a basis for the inverse ratio between intelligence and instinct is an animal's equipment on natural selection principles, *i. e.*, the more intelligence develops the less does natural selection bear on special instincts, and so they become broken up.

*'Sexual' is thus referred back to 'natural' selection (p. 274), although the direct results of such preferential mating would still seem to give very 'determinate' variations for natural selection to work upon (*Cf.* SCIENCE, Nov. 23, 1896, p. 726).

Finally, I should like to suggest that a possible category of 'Social Plays' might be added to Groos' classification—plays in which the utility of the play instinct seems to have reference to social life as such. Possibly in such a category it might be possible to place certain of the animals' performances, which seem a little strained under the other heads—for example, those performances in which the social function of *communication* is exercised early in life. A good deal might be said also in question of the author's treatment of 'Curiosity' (*Neugier*). He makes curiosity a function of the attention, and finds the restless activity of the attention a play function, which brings the animal into possession of the details of knowledge before they are pressed in upon him by harsh experience. My criticism would be that attention does not fulfil the requirements of the author's psychological theory of play, as indicated below.

Turning now to the interesting question of the psychological theory, we find it developed, as it would have to be, in a much more theoretical way. The play consciousness is fundamentally a form of 'conscious self-illusion' (311 ff)—*bewusste Selbsttäuschung*. It is just the difference between play activity and strenuous activity that the animal knows, in the former case, that the situation is not real, and still allows it to pass, submitting to a pleasant sense of illusion. It is only fair to say, however, that Herr Groos admits that in certain definite instinctive forms of play this criterion does not hold; it would be difficult to assume any consciousness of self-illusion in the fixed courting and pairing plays of birds, for example. The same is seen in the very intense reality which a child's game takes on sometimes for an hour at a time. Indeed, the author distinguishes four stages in the transition from instincts in which the conscious illusion is absent, to the forms of play to which we can apply the phrase 'Play activity' in its true sense, *i. e.*, that of *Scheinthätigkeit* (298 f). The only way to reconcile these positions that I see is to hold that there are two different kinds of play: that which is not psychological at all, *i. e.*, does not show the psychological criterion at all, and that which is psychological as *Scheinthätigkeit*. Herr Groos does

distinguish between 'objective' and 'subjective' *Scheinthätigkeit* (312). The biological criterion of definite instinctive character might be invoked in the former class, and the psychological criterion in the other. And we would then have a situation which is exemplified in many other functions of animal and human life—functions which are both biological and instinctive, and also psychological and intelligent, as sympathy, fear, bashfulness. Then, of course, the further question comes up as to which of these forms is primary, again the old question as to whether intelligence arose out of reflexes or the reverse.

I think some light falls on this time-honored question from the statement of it in connection with this new question of play, and especially when we remember Herr Groos' theory of the function of imitation and the extension of his view suggested above. If imitation stands midway between instinct and intelligence, both furthering the growth of instinct, and also leading to its decay in the presence of intelligence, then we might hold something like this: In proportion as an action loses its consciously imitative and volitional character, to that degree it loses its *Schein* character, and becomes real in consciousness and instinctive in performance (and this applies to the cases in which imitation has itself become habitual and instinctive); and on the contrary, in proportion as an instinctive action is modified and adapted through imitation and intelligence, to that degree it becomes capable of assuming the *Schein* character and is indulged in as conscious play. I cannot enlarge upon this here, but it seems to square with a good many of the facts, both those which Groos cites as showing that imitation opens the way for the decay of instinct with the growth of intelligence, and those which Morgan and I have cited as showing that imitation keeps congenital variations alive and so allows them to accumulate into instincts. And I think it so far confirms the view that imitation is a sort of meeting point of race habit, represented by instinct, and race accommodation, represented by intelligence—just the double function which imitation serves also in the development of the individual (*Cf.* My volume on *Mental Development*, in loc.).

Going into the analysis of the play psychosis, Herr Groos finds several sources of pleasure to the animal in it (203 ff): pleasure of satisfying an instinct, pleasure of movement and energetic action, but, most of all, 'pleasure in being a cause.' This last, together with the 'pleasure in experimenting,' which characterizes many play activities, is urged with great insistence. Even the imitative function is said to produce the joy of 'victory over obstacles.' Yet, here again, the author is compelled to draw the distinction between the play which is psychological enough to have a represented object, and the instinctive sort in which the pleasure is only that of the instinct's own performance. The pleasure of overcoming friction of movement, also, is very doubtful, since in any but the instinctive games which are cited (Chapter I.) to prove that the animal is not using up surplus energy (seeing that he plays after he is tired)—in other games we stop playing when the friction and inertia of the muscles become conscious as fatigue. Much more, however, is to be said for the pleasure of rivalry, or of overcoming an opponent, in the higher types of play; but Herr Groos scarcely does this justice.

Returning to the element of illusion in play, we find two ingredients in it (313 ff): a division of consciousness (*Spaltung des Bewusstseins*), *i. e.*, a division between the activity treated as real and the sense that it is unreal. There is considerable oscillation between these two poles. This ability to treat representations as realities is, according to Herr Groos, the essential of all imagination. In play it is akin to the division of consciousness found in certain pathological cases of double personality. It is a sort of hypnotization by the stream of representations, but with the sense that it is all an illusion and may be pierced through by a return to reality at any moment. This seems to me a true and valuable characterization of the play consciousness (it is taken from K. Lange), but Professor Groos' extension of it to all imagination does not seem to hold. In his criticisms of others (as the present writer) he fails to honor the current distinction between 'fancy' and 'constructive imagination.' In fancy we do yield ourselves up to a play of images, but

in the imagination of scientific thinking or of artistic creation are not both the goal and the process strenuous enough? This, indeed, leads Professor Groos to a view of art which allies it closely with the play function, but to that I return below.

The second element in the play or '*Schein*' consciousness is the feeling of freedom (*Freiheitsgefühl*) (331f). In play there is a sense, so to speak, of 'don't-have-to,' which is contrasted both with the necessity of sense and with the imperative of thought and conscience. This idea seems to be part of Schiller's theory of play. So Groos thinks the general feeling of freedom holds in consciousness only while there is a play of motives to which the agent may put an end at any moment—a sense of 'don't-have-to' in the life of choice. This sense of freedom keeps the *Schein* consciousness pure and prevents our confusing the play content with the possible real contents of life. This is very interesting and suggestive. The sense of freedom is certainly prominent in play. Whether it should be identified with the sense of control which has been used by some writers as a criterion (both in a negative and in a positive sense) of the belief in realities already experienced, or again with the freedom with which choice is pregnant, is more questionable. Without caring to make a criticism of Professor Groos' position, I may yet point out the distinction already made above between the two sorts of imagination, one of which has the 'don't-have-to' feeling and the other of which does not. So also in our choices there are those which are free with a 'don't-have-to' freedom, but there are choices—and these are the momentous ones, the ones to which freedom that men value attaches—which are strenuous and real in the extreme. Indeed, it seems paradoxical to liken the moral life, with its sense of freedom, to a 'game of play,' and to allow the hard-pressed sailor on the ethical sea to rest on his oars behind a screen of *Schein* and plead, 'I shan't play.' Seriously, this is something like the result, and it comes out again in the author's extremely interesting sections on art, of which I may speak in conclusion.

Those who have read Professor Groos' former stimulating book, *Einleitung in die Æsthetik*, will anticipate the connection which he finds between play and art. The art consciousness is a consciousness of *Schein*; it is also a play consciousness, inasmuch as it is the work of imagination—both the creative and the appreciative art consciousness—and the meaning of imagination is just that it takes *Schein* for reality. The 'self-conscious' illusion of the play consciousness is felt in extreme form in the theatre, and the pleasure of it is felt even when we play with painful situations, as in tragedy. In art the desire to make an impression on others shows the 'pleasure of being cause.' This intent to work on others is a necessary ingredient in the art impulse (312f). Groos differs from K. Lange, who holds a similar view of the necessary division of consciousness between reality and *Schein* in the æsthetic psychosis, in that Lange thinks there must be a continual oscillation between the two poles of the divided consciousness, while Groos thinks there is rather a settling down in the state of illusion (as in an artist's preoccupation with his creations, a novelist with his characters, and a child with her doll (323). In art the other great motive of play, 'experimenting,' is also prominent, and is even more fundamental from a genetic point of view; of that a word below.

Here, again, the question left in my mind is this: whether the play motive is really the same as the art motive. Do we not really distinguish between the drama (to take the case most favorable to the theory) as amusement and the drama as art. And does the dramatist who is really an artist write to bring on self-illusion in the spectator by presenting to him a *Schein* scene. Possibly, art theorists would divide here; the realists taking more stock in *Schein*, since realistic art is more nearly exhausted by imitation. This sort of illusion undoubtedly gives pleasure, and it is undoubtedly part of art pleasure. Yet there does seem to be, in a work of fine art, a strenuous outreach toward truth, which is additional to the instrument of appearance used by the artist—both in the production and also in the enjoyment. It may be that we should distinguish between truth which comes to us didactically and truth which comes artistically, and make

the method of the latter, and that alone, the source of æsthetic impression. In any case the theory of Groos, which has its roots in the views of Lange and v. Hartmann, is extremely interesting and valuable, especially as contrasted with the recent psychological theory of Mr. H. R. Marshall. In the present theory, the 'self-exhibition' of which Mr. Marshall makes so much, enters as the need of impressing others with the play illusion. As to the hedonic element and its ground, however, the two theories are in sharp contrast, and that of Groos seems to me, on the whole, more adequate. In the wealth of literary reference in his book Mr. Marshall pays singularly little attention to the authors from whom Groos draws, and none to the earlier work of Professor Groos himself, but treats the play theory only in the form of Mr. Spencer's surplus energy construction. As to Groos' theory musical art would present difficulties and so would lower sensuous æsthetic effects generally.

Genetically art rests upon play, according to Herr Groos, in that the three great motives of art production, 'Self-exhibition' (*Selbstdarstellung*), 'Imitation,' and 'Decoration' (*Ausschmückung*), are found in the three great classes of animal plays, respectively, 'Courting,' 'Imitation,' and Building Art' (*Baukünste*, seen in birds' nest-building, etc.). On the strength of this, Groos finds both æsthetic appreciation and impulse in the animal, and all rests upon the original 'experimenting' impulse. Of this, however, Professor Groos does not give a satisfactory account. Experimenting is a necessary part of effective learning by 'imitation,' I think, and the use made of it in the selection of movements may be its original use.

On the whole, Professor Groos' book is both a pioneer work and one of great permanent value; it should be translated into English. It contains a good index and a full list of the literary sources.

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Princeton.

*A Primer of the History of Mathematics.* By W. W. Rouse Ball. London, The Macmillan Co. 1895. Pp. 148, 16mo. Price, 65 cents.

*A History of Elementary Mathematics, with hints on methods of teaching.* By Florian Cajori. New York, The Macmillan Co. 1896. Pp. viii+304, 12mo. Price, $1.50.

The object of the 'Primer,' as well set forth in its introduction, is "to give a popular account of the history of mathematics, including therein some notice of the lives and surroundings of those to whom its development is mainly due, as well as their discoveries. Such a sketch, written in non-technical language and confined to less than 140 pages, can contain nothing beyond a bare outline of the subject, and, of course, is not intended for those to whom it is familiar." It consists of the author's larger work* reduced in size by the omission of all detailed and highly technical matter. In a few places the pruning process has been carried too far. For example, on p. 13 we are told that "after the execution of Socrates, in 399 B. C., Plato spent some years in travel * * * " but we are given no clue to the relationship of Socrates to Plato. However, the few instances of this kind which occur do not appreciably detract from the clear, well ordered and interesting style which the 'Primer' enjoys in common with its source.

The book affords to students in our high schools and colleges a means of gaining, with a small expenditure of time, a sufficiently complete history of the mathematical subjects they are studying, to give them a much greater appreciation of and interest for such subjects.

As its title indicates, Professor Cajori's book does not cover the entire field of mathematics; he restricts it to arithmetic, algebra, geometry and trigonometry, as presented in undergraduate instruction, with a short account of the history of non-Euclidean geometry. The arrangement of the material is first under the headings: 'Antiquity,' 'Middle Ages,' 'Modern Times;' under each of these are the subdivisions: 'arithmetic,' 'algebra,' 'geometry' and 'trigonometry.' For a work of its size it contains a great deal of information, and nearly every statement is supported by a reference either to original sources or to other treatises upon mathematical history. The chapters upon arithmetic are par-

*A short account of the History of Mathematics. London, the Macmillan Co. 2d edition. 1893. Pp. xxiv+520, 16mo.

ticularly rich in examples of methods of calculating which have long since disappeared from our arithmetics, and, as the author points out, some of these are, by no means, inferior to those now used. Such examples make the history of arithmetic very real to one. The sections entitled 'Causes which checked the growth of demonstrative arithmetic in England,' 'Reforms in arithmetical teaching,' and 'Arithmetic in the United States,' show forcibly the stagnation which results in regarding it not as a demonstrative science, but merely as an art of calculation.

The accounts of modern synthetic geometry and of non-Euclidean geometry (pp. 252–275) seem well chosen. It is necessary for teachers of geometry to have a broader view of their subject than is afforded by the typical text-book.

Having called attention to some of the merits of Professor Cajori's work, it is unfortunately necessary now to note some of its defects. The inconvenient method of introducing an abbreviation, the first time a work is cited, to be used for it subsequently, we trust will in future editions be remedied by a table at the end of the volume. It is confusing, if one is not certain of their identity, to have 'Ptolemy' and 'Ptolemæus' used indiscriminately. In the statement that "$\sqrt{2}$ cannot be exactly represented by any number whatever" (p. 51), the word rational has, of course, inadvertently been omitted. Foot-note 3, p. 72, is very indefinite in its present form. Referring to remarks at the top of page 74, we quite agree with the author that rigor in geometry demands the proof of the *possibility* of all constructions before they are used. For example, that the circumference of a circle admits of being divided into any number of equal parts should be shown (which involves no difficulty) before considering regular inscribed polygons in general. The example of the text leads one to suppose that rigor demands our ability to construct (subject, in fact, to the arbitrary condition of having only ruler and compass) every inscribed polygon we may wish to use.

The material of the volume in places shows lack of coordination and incomplete moulding into an organic whole. One feels at times lost in a maze of fact. We are given part of the biography of Leonardo of Pisa on page 119 and part on page 134. The origin of the word 'sine' is found on page 124 and again on page 130. On page 75 and again on page 78 we are told of the tomb of Archimedes.

In the foot-note 1, page 160, the conclusion that the base of Napier's logarithms is $e^{-1}$ is erroneous, and it does not follow from what precedes it. If we define the logarithm of $x$ with respect to the constant base $b$, by the equation $x = b^{\log x}$, then the numbers discovered by Napier are not logarithms; but if $b$ is not restricted to be constant, the above equation defines Napier logarithms when

$$b = 10^{\frac{7}{\log x}} \div C^{\left(\frac{1}{10}\right)^7}$$

(Hagen, Synopsis der hoeheren Mathematik I., p. 107.) To define the base of Napier's logarithms as the number whose logarithm is unity is in this case misleading. The term is, however, so used by Cantor (Geschichte der Mathematik, II., p. 672), who gives its value to be

$$10^7 \div C^{\left(\frac{1}{10}\right)^7}.$$

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*Die Bedingungen der Fortpflanzung bei einigen Algen und Pilzen.* Von DR. GEORGE KLEBS. Jena, Gustav Fischer. 1896. Pp. i.+543, 3 plates.

This work of Dr. Klebs' is an important contribution to the physiology of reproduction. As its title indicates, the experiments were conducted for the purpose of determining the conditions of reproduction in certain algæ and fungi. A preliminary account of some of this work has been published in earlier contributions. The earlier experiments have been amplified and extended to a number of additional plants, and the present work details carefully his later experiments and presents the philosophy and deductions of all his work upon this topic. It is a remarkable work, alike for the painstaking conduct of the experiments, the precautions against error, the important results obtained and the cautious generalizations upon the relations of the different kinds of reproduction to environment. Not only is the work one of great interest to the student of develop-

ment and to those interested in the theoretical questions of reproduction, but it is one which will be a great aid to teachers who wish to supply material of these lower forms of algæ to their classes in a condition in which these processes of reproduction can be observed. This is especially so in the case of certain species of *Vaucheria*, *Hydrodictyon*, *Oedogonium* and others, since the conditions have been determined under which one can with certainty bring the material to the production of zoospores, or to the development of sexual organs within a reasonable limit of time.

His most extended experiments were conducted upon species of *Vaucheria*, especially upon *Vaucheria repens*, *clavata* and *sessilis*, or upon the composite species *Vaucheria sessilis*, as some would treat it. Klebs would, however, treat these three forms as species, and it is interesting to see how the reactions of these three forms toward various conditions of environment and artificial treatment give support to the view that they may be regarded as species, and we are promised a thorough-going revision of the species of *Vaucheria* from the hand of one of Dr. Klebs' students.

The experiments cannot be given in detail, but under the head of the asexual reproduction through zoospores the methods employed were similar to those noted in 1892. Plants cultivated in the light and in moist atmosphere, on being transferred to water produce numerous zoospores; cultivated in a 0.2 per cent. to 0.5 per cent. nutrient solution (inorganic salts) in the light, on being transferred to pure water produce zoospores. On the other hand, cultures in water, or in a 0.1 per cent. to 0.2 per cent. nutrient solution, produce zoospores on simply being darkened. The development is especially active when the first or second method is combined with the third. In studying the conditions which influence sexual reproduction he found *Vaucheria repens* the best subject, though any of the species studied could be brought with certainty in artificial cultures to form sexual organs. For example, threads of *Vaucheria repens* placed in a 0.2 per cent. to 0.4 per cent. cane-sugar solution form sexual organs with the greatest certainty in four to five days. In studying the influence of light he found that it acts in a two-fold manner. Through the assimilation of $CO_2$ reserve material, in the form of organic compounds, which is necessary for sexual reproduction, is supplied, and the light also acts in a direct way stimulating the process. This was proved by growing cultures under conditions where an abundance of light was supplied, but the plants were deprived of the $CO_2$ of the air, so that none or little carbon assimilation took place and no sexual organs were formed. Cultures, under similar conditions, in a cane-sugar solution, produced sexual organs, the reserve material here being supplied by the sugar solution. On the other hand, cultures in a cane-sugar solution in weak light or in darkness produced no sexual organs. The same results were obtained in cultures of other genera of algæ, and his conclusions that light acts in a twofold manner seem justified.

In studying the conditions which influence the male or female organs some interesting results were obtained, though no definite conclusions were reached regarding the relation between these two kinds of organs. Cultures in a thermostat at 25° to 26° C. showed a tendency to complete suppression of the oogonium or to a vegetative growth of the same, the number of oogonia in a group being not increased, while the antheridia were increased in number in some cases as much as five- to seven-fold. Cultures under air pressure of 120 mm. gave similar results.

In his studies of *Drapernaudia glomerata* he discovered microzoospores and observed their conjugation to form zygospores. Pringsheim, in 1860, first observed resting cells, and speaks of the formation of microzoospores, though he does not describe them. Klebs first observed them in 1894. Algæ were taken from a cold standing culture and placed in a 2 per cent. cane-sugar solution in the heated laboratory. After twenty-four hours zoospores were formed, and after forty-eight hours microzoospores appeared. The microzoospores are oval to spherical and about half the size of the zoospores, and are four ciliate. The red-eye spot is near the base of the body while in the zoospores it is situated at the upper third. Many of the microzoospores form resting spores parthenogenetically, though, as stated above, Klebs was

able to observe certain of the resting cells formed by the conjugation of two microzoospores.

In his studies upon *Botrydium granulatum* he determined by pure cultures that what has been regarded as a remarkable pleomorphic species really represents two distinct species. His attention was first called to this confusion by the difference in the cell structure of the various forms. In one the chlorophyll bodies are in the form of distinct discs, while in the other the chlorophyll is a single connected plate. In one the cells form a fatty oil but no starch, while the other possesses amylon grains and starch bodies, their structure being like that of the cell of Hydrodictyon. One of these plants is a true *Botrydium*, while the other is the *Protococcus botryoides*, described by Kuetzing in 1845, and in 1855 Cienkowski correctly described its development. Since the genus *Protococcus* is untenable, Klebs proposes the name of *Protosiphon botryoides* for this plant.

He takes occasion to deplore the tendency of some algologists to repeat in the case of the algæ the pleomorphic craze which once brought such confusion to bacteriology and mycology, citing especially Hansgirg, in 1855, and the more recent work of Borzi and Chodat, who claim to have connected a large number of genera in the form cycle of one species. He points out that these investigators did not use pure cultures and were thus led to include in the form cycle different genera appearing in the culture. It has been held by some that if filamentous algæ possess protococcoid forms in one stage of development, then all protococcoid forms are states of filamentous algæ. It is impossible to distinguish the swarming gametes of Chlamydomonas and Ulothrix, still it does not follow that Chlamydomonas belongs to Ulothrix. He insists that in studies of development pure cultures should be used, though pure cultures in the sense in which they are made in bacteria and the fungi cannot be made. Pure cultures and continuity of observation, especially in connecting different stages, should be substituted for mixed cultures and discontinuous observations.

Space will not permit a discussion of his experiments upon other genera of *algæ* and the *fungi*, but the following outline of his experiments upon *Vaucheria* will give an idea of the thorough and comprehensive manner in which his work was conducted.

I. The asexual reproduction through zoospores of *Vaucheria repens* and *clavata*.
   1. Influence of nourishment.
   2. Influence of dampness.
   3. Influence of light; of darkness; of weak light; of the rays of the spectrum; of light intensity; of carbon assimilation.
   4. Influence of temperature; low temperature; high temperature; mean temperature and variations of temperature.
   5. Influence of the chemical peculiarities of the medium.
      A. Inorganic compounds; effect of nutrient salts; change from nutrient salts to water.
      B. Organic compounds; cane sugar; camphor.
      C. Osmotic value of the compounds.
      D. Influence of acid or alkaline reaction.
      E. Influence of oxygen; influence of air pressure; of rarified air.
      F. Influence of flowing water; of friction; of temperature; of oxygen and nutrient salts.

II. The asexual increase in the case of other species of *Vaucheria: Vaucheria ornithocephala;* aplanospores of *V. geminata;* conditions of their formation; aplanospores of *V. racemosa, uncinata.*

III. The sexual reproduction of *Vaucheria.*
   1. Influence of light.
      A. Effect of light as a means of nourishment.
      B. Influence of light intensity.
      C. Significance of colored light.
   2. Influence of dampness.
   3. Influence of temperature.
   4. Influence of chemical peculiarities of the medium.
   5. Influence of oxygen.
   6. Influence of flowing water.
   7. Upon the relation of the male and female sex.

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*Codice Messicano Vaticano, No. 3773.* EDIZIONE DEL DUCA DE LOUBAT. Roma. 1896.

In the native literature of America that which was the product of aboriginal authors, the pictographic manuscripts, or 'codices,' as they are called, of Mexico and Central America, hold the first rank. Quite a number of them, though generally in an imperfect condition, have been preserved which date from before the

conquest of the country by Europeans. Most of these are the work of tribes speaking either the Nahuatl (Aztec) or the Maya languages; but others are from the Zapotec or Mixtec regions, these representing different linguistic stocks.

The accurate reproduction, by modern methods, of these remarkable monuments of a perished civilization is one of the most valuable services which can be rendered to the study of American archæology; and in presenting in all respects a fac-simile of one of the most perfect, the Codex Vaticanus No. 3773, the Duke de Loubat has added another and a most important item to his many claims on the gratitude of those interested in the ancient history of America. His edition leaves nothing to be desired in point of faithfulness to the original; and that it is in fact a gift to science, being chiefly distributed to public libraries, excites just admiration for the liberality as well as the appreciative scholarship of the donor.

The Codex in this edition is accompanied by two articles from the pen of the well-known archæologist, Father Francisco del Paso y Troncoso, one on the proper sequence of the pages of the manuscript, the other on its probable age and origin. The former is indispensable to its comprehension.

This Codex was included by Lord Kingsborough in his great work published in 1831; but not only was the copy prepared by his artist defective in various particulars, but its pages were erroneously arranged, so that the study of it became hopelessly confusing.

From what is know of the classes of native writings, this Codex is recognized as of Nahuatl origin and is concerned with the ritual year of 260 days, doubtless either in its divinatory applications, or as regulating the fasts, festivals and other religious ceremonies of the temples. The opening pages give the *tonalamatl*, or list of days, and on the last is the picture of a masked figure indicating the astrological relationship of the various parts of the body.

As we have in the 'Borgian Codex' a document from the same locality, and also ritual in its character, there are facilities for the explanation of this Vatican Codex not to be found in other instances.

So far as its history is concerned it rests in obscurity. It was certainly in the Vatican library as early as 1596, and may have reached there about 1550. But, of course, no question can be raised concerning its authenticity, and its composition previous to any European influence in Mexico. We thus have, by the generous action of M. de Loubat, placed within the reach of students probably the best conserved example of that once rich native literature in which were stored the history, religion and science of aboriginal American civilization.

D. G. Brinton.

## SCIENTIFIC JOURNALS.

### AMERICAN CHEMICAL JOURNAL, FEBRUARY.

*A Contribution to the Study of Water Solutions of Some of the Alums:* By H. C. Jones and E. Mackay. Various methods have been used in investigations of the conditions existing in a solution from which double salts will crystallize out. The question to be decided was whether the double salt was present as such in solution, or was formed at the moment of crystallization. The methods used may be grouped under the following heads, as they have to do with (*a*) the diffusion, (*b*) the thermal changes, (*c*) the volume changes, (*d*) the solubility, (*e*) the electrical properties, or (*f*) the cryoscopic behavior of solutions of the compounds under investigation. After reviewing these methods the authors state that the aim of the present work was to obtain, from a study of the conductivity of solutions of alums, data which would justify more definite conclusions than had yet been drawn. They have compared the electrical conductivity and cryoscopic behavior of the double salts with that of their constituent salts to see if they corresponded to mixtures. The methods of work, analyses and preparation of various alums are given. The results obtained by the conductivity method show that in dilute solutions the complex alum molecules are broken down completely into the molecules of the simpler sulphates, which dissociate as if alone, while in more concentrated solutions the alums are either partially undecomposed or the dissociation is not complete. Potassium chrome alum apparently exists as such in moderately concentrated

solutions. These results in general are confirmed by the freezing point measurements.

*Silicides of Copper and Iron:* By G. DECHALMOT. In a former number of this journal the author described a silicide of copper of the composition $Cu_2Si_3$. Upon repeating the work with different specimens he found that the substance obtained was a mixture of silicon, copper silicide and copper. The mixture forms apparently homogeneous pure crystals, which fact led him to think they were of the composition given above. He has also obtained a silicide of iron to which he gives the composition $FeSi_2$.

*Formation of Diacetylenyl (Butadiine) from Copper Acetylene:* By A. A. NOYES and C. W. LUCKER. Several investigators have described a crystalline product obtained by the action of acetylene (from copper acetylene) on boiling bromine. The composition ascribed to it was $C_4H_2Br_6$, and the present investigation was undertaken to verify this and to determine the origin of the compound. Pure acetylene (from calcium carbide) would not produce it, and it was finally discovered that the action would take place more readily if cupric chloride was added to the copper acetylene before its decomposition, as the formation was due to the oxidizing action of the cupric chloride formed by the action of the air on the copper acetylene and hydrochloric acid. The study of the compound led to the conclusion that it is formed by the direct union of the hydrocarbon $C_4H_2$ with bromine.

*On the Action of Acid Chlorides on the Imido Esters and Isoanilides, and on the Structure of the Silver Salts of the Anilides:* By H. L. WHEELER and P. T. WALDEN. The authors thought that light might be thrown on the constitution of the silver salts by the study of the action of acid chlorides on compounds that are definitely constituted as the silver salts are supposed to be. From the action of acid chlorides on isoanilides and imido esters results were obtained which admit of only one interpretation according to which the reactions are explained, not by tautomerism, but by addition. This proves also that the metal in the silver salts of the anilides is directly joined to oxygen. The reactions of acid chlorides with imido esters also showed that diacid amides have both acid groups attached to the nitrogen. These results were further confirmed by the action of the halogens on the imido esters.

*On the Effect of Light on the Displacement of Bromine and Iodine from Organic Bromides and Iodides:* By J. H. KASTLE and W. H. BEATTY. In studying the decompositions of the halogen derivatives of the sulphonamides it was found that the halogen was set free, to a considerable extent, by the action of sunlight. If a substance containing both chlorine and bromine is exposed to the sunlight in a sealed tube with water the chlorine is first set free, and after some time, from the action of this chlorine, the bromine is set free. Chlorine set free in this way could displace bromine and iodine from their most stable compounds. Parallel experiments carried on in the sunlight and in the dark showed that up to 50° no change took place in the dark, while the action in the light was marked.

*The Specific Gravities of Water Solutions of Formic Acid:* By G. M. RICHARDSON and P. ALLAIRE. The authors have determined the specific gravity of solutions of formic acid, making seventy-one determinations between the pure acid and a solution containing only 0.618 per cent., and have tabulated the data obtained.

*The Constitution of Benzanilide:* By N. KNIGHT. There are two possible formulæ for benzanilide, and a method which was suggested to establish the correct one was to study the reactions of benzene sulphanilide with benzoylchloride and of benzanilide with benzenesulphonchloride. The results, however, were different from those expected, dibenzoylanilide being the chief product, and no important conclusions as to the structure could be drawn.

A number of recent publications are also reviewed in this number of the *Journal*, viz.: *Traité de chemie organique d'après les theories modernes*, A. BÈHAL; *Analytical Chemistry*, N. MENSCHUTKIN; *Recherches sur la congelation des solutions aqueuses étendues*, M. A. PONSOT; *Kurzes Lehrbuch der organischen Chemie*, A. BERNTHSEN; *Studies in Chemical Dynamics*, J. H. VAN'T HOFF; *The Chemical Analysis of Iron*, A. A. BLAIR (3d edition); and *Gas and Fuel Analysis for Engineers*, A. H. GILL.

J. ELLIOTT GILPIN.

THE JOURNAL OF COMPARATIVE NEUROLOGY, DECEMBER, 1896. DOUBLE NUMBER.

*The Brain of the Bee—A Preliminary Contribution to the Morphology of the Nervous System of the Arthropoda:* By F. C. Kenyon, Ph.D., Clark University. This memoir contains the first really successful and comprehensive application of modern methods to the central nervous system of the insects. Dr. Kenyon was very successful with the newer silver and hæmatoxylin methods, though the difficulties in this research were very great. This communication contains a detailed description of the structure, especially the fiber connections, of the brain of the honey bee, with the exception of the optic lobes, which are reserved for separate treatment. Thirty-two cell groups are enumerated and their connections given so far as known. The text comprises 78 pages and there are nine plates, three of photographs, two of silver preparations and four charts in colors showing the courses of the fibers in detail. Among the results perhaps the most interesting relates to the structure of the so-called mushroom bodies. Additional evidence is adduced to show that the function of these peculiar bodies is that of enabling the insect to intelligently adapt itself to its surroundings. They are shown to be connected at their calices with two pairs of sensory tracts of fibers from the optic lobes, with three from the antennal lobes and with one that is probably also sensory from the ventral nervous system. Their roots are shown by fragmentary evidence, sufficient to warrant the conclusion, to be very probably connected with the inner terminals of motor, or possibly of other efferent fibers.

*The Origin and Growth of Brain Cells in the Adult Body:* By Howard Ayers. The recent discovery of the centrosome in both vertebrate and invertebrate nerve cells has brought into prominence anew the question as to whether the current doctrine that adult nerve cells do not divide is true. It will be remembered that Herrick and others have long claimed that it is not, and now Dr. Ayers brings forward fresh evidence. In the brain of the adult Torpedo he finds cells dividing in a very characteristic manner and these are especially abundant in the electric lobes. The centrosome was found, but the division is apparently amitotic. In the electric lobes there is also another remarkable feature. The overgrown ganglion cells have applied themselves to the walls of the arterial capillaries and there spread themselves out, thus affording the best possible facilities for nutrition.

*The Innervation of the Auditory Epithelium in Mustelus canis DeKay:* By A. D. Morrill. This paper gives a summary of the results of some very successful methylen blue preparations of the ear of the smooth dog-fish. No continuation of the nerve into the cell was observed, although the cells were semi-transparent. Satisfactory evidence of anastomosis of nerve fibers was not obtained. There are two kinds of nerve endings in the auditory epithelium, the one being free near the surface, and the other ending in knob-like structures in contact with the base of the hair cells.

*Neural Terms, International and National:* By Burt G. Wilder, M. D., Cornell University. In this extensive paper of 136 pages Dr. Wilder has brought together the main points in his voluminous writings on nomenclature, together with much new matter, and has arranged the whole in the form of a systematic presentation of the principles of nomenclature and their application to the nervous system, which should be a standard of reference for many years to come. The immediate occasion of the paper is the report of the Committee on Anatomical Nomenclature of the Anatomische Gesellschaft, Basel, 1895. As this German committee is to report again after three years, it is very desirable that in the meantime all questions of nomenclature should receive careful attention. The paper contains a valuable list of definitions of terms employed in the discussion, a review of the author's work on nomenclature, full discussions on the reports of the American and German committees and extensive comparative tables of terms of brain anatomy, together with a bibliography.

AMERICAN GEOLOGIST, FEBRUARY.

A tribute to Professor Ch. Fred. Hartt, By Frederic W. Simonds.

Dr. F. W. Sardeson continues his correlation studies on the Galena and Maquoketa

series. In this paper he discusses the species commonly known as *Orthis testudinaria*, and concludes that several separate forms are generally comprised in it and that the original species has no typical American representative.

Professor Jules Marcou finishes his review of 'Rules and Misrules in Stratigraphic Classification.' Especial application is made to various members of the Orodovician, Mesozoic, Tertiary and Quaternary. In a postscriptum the three official geological maps of the State of New York are compared in some detail.

The extreme rapidity of weathering and stream erosion in the artic latitudes is described by Professor R. S. Tarr. The abundant lichen flora, the air and water and the great variations of temperature are the active agents.

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## *SOCIETIES AND ACADEMIES.*

### NEW YORK ACADEMY OF SCIENCES, FEBRUARY 1, 1897.

### SECTION OF ASTRONOMY AND PHYSICS.

THE first paper was one postponed from last month by H. Jacoby, 'On two Trailplates of Circumpolar Stars, made by Anders Donner at the Helsingfors Observatory.'

It was explained that these photographic negatives of circumpolar stars were taken with the telescope stationary, and hence that each star left a trail upon the plate, which, after necessary corrections, would be an arc of a circle around the true north pole of the heavens. The exposure, which was for a few moments at intervals of a half hour, extending over 14 hours, thus gave a series of short arcs extending over a little more than a semicircle. This method, if no unforeseen difficulties appear, should give the position of the pole to within a few hundredths of a second of arc and a system of right ascensions differing from the truth by a uniform correction.

The paper was discussed by R. S. Woodward and others.

Mr. P. H. Dudley then presented a paper under the following title: 'Investigations of Undulations in railway tracks by his track indicator, and the reduction of two-thirds of the amount in the last fifteen years, by the use of his stiff-rail sections.'

Mr. Dudley pointed out the causes and character of the inequalities in railroad rails, and described his very perfect car for obtaining a complete record of the condition of the track while travelling at 20 to 25 miles per hour. Among other records given is the summation of the inequalities of the rail per mile. A dozen years ago this total unevenness amounted to six or seven feet even on the better roads; now as a result of the records of the car, and of new designs and methods of manufacture of rails, the total has been reduced to 18 to 20 inches. It was shown that this remnant was due to dents in the rails and could not be helped by work on the road bed, but must be reduced by further improvements in the manufacture of the rails.

Sections of rails and indicator records were exhibited, and lantern slides shown to illustrate the above improvements on the New York Central and Boston and Albany system. A great proportion of the gain is due to the improvement in Mr. Dudley's improved rail sections, which give a maximum of rigidity and wear, with a minimum of weight.

R. S. Woodward pointed out the extreme importance of many of the problems upon which Mr. Dudley is working, and hoped that the author's idea of a rail-rolling machine, which would turn out a 60-ft. rail *straight* and *cold*, would soon be put into operation. W. Hallock remarked upon the advantages to science which were sure to come from the author's investigation of many physical questions which cannot be studied in a laboratory and need a railroad to experiment with.

J. J. Stevenson called attention to what the community at large owes to Mr. Dudley's improvements. It means heavier engines, heavier cars, longer trains, greater speed, reduced freight and passenger rates, all of which greatly contribute to the general welfare and the advance of civilization.

H. S. Curtis presented a paper on 'The advantages of long-focus Lenses in Landscape Photography.' After referring to the unsatisfactory results of photographing landscapes with ordinary lenses, owing to false perspective and lack of detail, he showed how this was remedied by lenses of longer focus. A telescopic

combination of 40-inch focal length was used by reversing the lens and putting the flint and crown about 1 mm. apart. A number of views were shown to illustrate the advantages of such lenses.

Several pictures were taken with an ordinary spectacle lens, 34-inch focus, stopped to about $\frac{1}{8}$-inch diameter, which were very good indeed and scarcely distinguishable from those taken with the telescopic lens or a telephotic combination. Such a lens can be bought for ten cents.

J. F. Kemp spoke of the comparative uselessness of ordinary photographs in the study of mountain geology, and believed that such a simple camera would be of great value in field work. The paper was discussed by others.

Wm. Hallock,
*Secretary of Section.*

NEW YORK ACADEMY OF SCIENCES—SECTION OF GEOLOGY, FEBRUARY 15, 1897.

The first paper of the evening was by Mr. F. C. Nicholas, and was entitled 'Explorations in in the Gold Fields of Western Colombia.' Mr. Nicholas described the curious placers in western Colombia, which, while extremely rich in limited portions, are of very low grade when considered as extended propositions. The gold gravels occur along the western base of the Andes Mountains, and extend from the Gulf of Darien southward, up the Atrato River, to Quibdo. They are also found to the southward of the San Juan River and are in the form of terraces similar to the terraces of the Atlantic States. After the formation of the auriferous gravels the speaker supported the view that igneous intrusions and upheavels had cut them off from their parent hills in the interior and had recognized the drainage, so that the streams do not now head in auriferous rocks. The surface geology indicated that the Gulf of Darien formerly extended a long distance up the valley of the Atrato. Quite detailed descriptions of the gravels and of the character of the terraces were given in the paper. Mr. Nicholas described a route by which a man could sail in a canoe from the Atlantic to the Pacific in the wet season by going up the Atrato River to the Quito River, thence to the divide, which is in a series of swamps, thence into the San Pablo River and on down the San Juan to the Pacific.

The second paper of the evening was by Professor R. E. Dodge, entitled 'Recent Work in Physiography.'

Professor Dodge gave an outline of De Lapparent's 'Leçons en Geographie Physique,' of Sir John Lubbock's 'Scenery of Switzerland,' and of two recent papers, one by M. R. Campbell, entitled 'Drainage Modifications and their Interpretation,' and the other by C. F. Marbutt, 'On the Physical Features of Missouri.'

The last paper of the evening was by A. A. Julien, on the 'Sculpture and Sorting of Sands.' The speaker, by means of lantern slides, illustrated various varieties of sand and their chief methods of origin and their composition. After citing the schemes for the classification of sands advanced by Zirkel and Daubrée he gave one of his own which was more elaborate and was partly based on the method of origin and partly on the physical characters.

J. F. Kemp,
*Secretary.*

AMERICAN CHEMICAL SOCIETY—NEW YORK SECTION.

The meeting was held at the College of the City of New York on Friday, February 5th, at 8:30 p. m., Dr. Wm. McMurtrie presiding, and about fifty members present.

The first hour was occupied with the 'Discussion of the Relations of the Section with the Scientific Alliance.'

Professor Breneman opened the discussion. Dr. Wiley described the work done by the Affiliated Societies of Washington, the advantages resulting from cooperation and more which might result from a little additional effort. He stated that, with possibly one exception, the Washington Societies were all strictly professional.

Professors Sabin, Doremus and others spoke strongly in favor of the Alliance; others thought the promised advantages had not materialized and that the returns were not proportionate to the annual subscription.

Dr. H. W. Wiley read a paper on the 'Value of Foods and the Methods of Ascertaining it,'

pointing out the disparity, at least until very recently, in the relative amounts of investigation and interest bestowed upon 'man foods' and animal foods. He described the classes of foods rated according to their fuel values, digestibility, etc., and noted the divergence between price and actual food value of many articles, some of them not luxuries.

The papers announced on 'Volumetric Estimation of Lead,' by J. H. Wainwright, and 'Electrolytic Production of Alkali Nitrites,' by Wm. M. Grosvenor, were held over until next meeting.

DURAND WOODMAN,
*Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON, 58TH MEETING, JANUARY 9, 1897.

MR. WHITMAN CROSS read a paper on 'The igneous rocks of the Leucite Hills and Pilot Butte, Wyo.,' in which he stated that the rocks of the Leucite Hills occur as surface flows and in volcanic necks or plugs. The leucite rock described by Zirkel, 20 years ago, is the least abundant type in the region, the other varieties containing more or less potash feldspar, as pointed out by Kemp in his recent communication to the Geological Society of America. Chemical analyses of various rock types were submitted, together with analyses of the pyroxene and mica.

The rock of Pilot Butte, an isolated point near the Leucite Hills, was also described and its chemical composition shown by an analysis. This rock is closely related to the leucite rocks, although containing much glass.

In a large cavity of the leucite rock was found a quantity of potash nitre, and on a protected face of the Boar's Tusk, a volcanic plug, was observed a white coating of soda nitre. The origin of these nitrates, whose mode of occurrence is so unusual, is not explained by any observations made.

This communication will soon be published in some scientific serial.

Mr. W. Lindgren read a paper on 'The Granitic Rocks of the Sierra Nevada,' in which he called attention to the large areas of intrusive granitic rocks occurring along the Pacific coast and to the fact that these intrusives are of comparatively recent date, probably early Cretaceous. A map of the distribution of the various kinds of granitic rocks in the northern part of the Sierra Nevada was exhibited. It was shown that, while some true granite exists, the largest mass is made up of grano-diorite, a rock intermediate between granite and diorite or, more accurately, intermediate between a quartz-mica-diorite and a quartz-monzonite, recently defined by Brögger.

W. F. MORSELL.
U. S. GEOLOGICAL SURVEY.

BOSTON SOCIETY OF NATURAL HISTORY.

A GENERAL meeting was held January 6th, eighty persons present.

Mr. A. W. Grabau read a paper on the sand-plains of Truro, Wellfleet and Eastham. (For an abstract see above p. 344.)

Professor N. S. Shaler, in commenting upon Mr. Grabau's paper, said that his observations agreed with those of Mr. Grabau as to the origin of the sand plains. The slopes are due to a complexity of causes and frequently cannot be discriminated. The hypothesis of fresh-water lakes and the ponding of streams was rejected as inadequate. Professor Shaler said that the agency of ants in the formation of these sand plains was very great, and should be considered in relation to any theory accounting for them.

Mr. J. B. Woodworth spoke of the difficulty of making out the internal structure of sand plains; he had observed that the gravels near the head were coarser than those from other parts. Mr. Woodworth compared the sand plains of the Cape region as described by Mr. Grabau with those he had studied in the Narragansett Bay district. The hypothesis of fresh-water lakes applies equally to the Narragansett Bay district. The kettle holes indicate masses of ice after the melting of the ice sheet.

Prof. W. M. Davis claimed that the slopes could be discriminated, but that they should not be solely relied upon.

Professor Shaler contended that the slope depended upon the material, and that the original angle is unreliable until the material is known. The difference of height of sea level should be

considered, and the origination of the deltas in the sea was advocated.

Mr. Grabau replied briefly to some of the points raised in the discussion and emphasized the differences between erosion slopes and construction slopes; the pointing of the slopes was stated; the material on the northern side of the sand plains was perhaps coarser.

Professor W. M. Davis defined briefly and with graphic illustrations coastal plains, and gave the outline for a geographic classification of the same. He advocated the use of distinctive descriptive names, and stated that the introduction of such terms as *doab* and *cuesta* would be of advantage to geographic science.

Professor Shaler claimed that many of the terms could be expressed by words in our own language, and that the introduction of words from foreign sources was to be deprecated.

SAMUEL HENSHAW,
*Secretary.*

### THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of February 1, 1897, Professor L. H. Pammel read a paper embodying ecological notes on some Colorado plants, observing that botanists who have studied the Rocky Mountain flora have frequently commented on the interest attached to the plants from an ecological standpoint, but most perplexing to the systematist. It is not strange that this should be the case, since there are great differences in altitude and soil, and the relative humidity of the air varies greatly. This is a most prominent factor in the development of plant life. A cursory glance at the plains flora of eastern Colorado shows that there are representatives of a flora common from Texas to British America and east to Indiana. We should not for a moment suppose that the species are identical in structure, since the conditions under which they occur are so different. Attention was called to the great abundance of plants disseminated by the wind, as *Cycloloma*, *Salsola*, *Solanum rostratum*, *Populus*, *Cercocarpus*, 'Fire-weeds' (*Epilobium spicatum* and *Arnica cordifolia*), *Hordeum jubatum*, *Elymus sitanion*, etc. Plant migration may be studied to better advantage in the irrigated districts of the West than elsewhere, partly because the water carries many seeds and fruits in a mechanical way, and partly because the soil is very favorable for the development of plants. Instances were cited where several foreign weeds are becoming abundant, as *Tragopogon porrifolius* and *Lactuca Scariola*. The latter, known as an introduced plant for more than a quarter of a century, is common at an altitude of 7,500 feet in Clear Creek Cañon. Once having become acclimated, it is easy to see how Prickly Lettuce is widely disseminated.

Collectors appreciate the great importance of giving more attention to conditions under which plants thrive, such as phases of development, soil, climate and altitudinal distribution. Structures of plants are produced to meet certain conditions. Under extreme conditions protective devices are more pronounced. In discussing some of the plants, Warming's classification into Hydrophytes, Xerophytes, Halophytes and Mesophytes was adopted. The Mesophytes of eastern Iowa were compared with some of the Xerophytes of western Iowa, such as *Yucca angustifolia*, *Mentzelia ornata*, *Liatris punctata*, etc. These increase in abundance in western Nebraska, and attain a maximum development in northern Colorado. In the foot-hills and mountains the Mesophytes constitute a large class, although the Xerophytes are common in dry, open, sunny places. The photosynthetic system is reduced to guard against excessive transpiration which would otherwise take place at high altitudes. The thick rootstock of alpine plants in dry open places is an admirable protection against drouth and cold. In cañons where snow remains on the ground plants do not need this protection. Halophytes are not numerous in species and genera. Hydrophytes are abundant at higher altitudes, where they occur in marshes and along streams.

At the meeting of the Academy of Science, of St. Louis, on the evening of February 15, 1897, Professor J. H. Kinealy presented a preliminary discussion of the Poley air-lift pump, a device for pumping water from artesian wells by injecting into the pump tube, at a considerable depth below the surface of the water, bubbles of air from an air compressor.

Mr. Trelease exhibited two hair balls removed from the stomach of a bull in Mexico, and showed that they were composed of the pointed barbed hairs of some species of prickly pear upon which the animal had unquestionably fed. Attention was called to similar balls from the stomachs of horses, which had been described in 1896 by Mr. Coville, of the United States Department of Agriculture.

WM. TRELEASE,
*Recording Secretary.*

### THE TEXAS ACADEMY OF SCIENCE.

AT the regular meeting of the Texas Academy of Science, held in the chemical lecture room of the University of Texas, at Austin, on Friday, February 5, 1897, Lieutenant W. V. Judson, U. S. A., presented a paper on 'The Improvement o Galveston Harbor.'

This important communication, by one of the engineers in charge, dealt with the following topics: (1) Introduction, The Problem in the Case. (2) Physical Characteristics, etc. (3) Early Operations. (4) Project of 1880 and Work there under. (5) Project of 1886. (6) Operations 1886–1891. (7) Continuous Contract System. (8) Contract with O'Conner, Laing and Smoot. (9) Dredging. (10) Physical Results.

In stating the problem, the speaker, after defining natural harbors, briefly discussed 'bars,' which he grouped into the following classes: (1) Drift Bars on seaward side of passes into areas embayed by sandy islands and peninsulas. (2) Drift Bars at the mouths of rivers emptying into non-tidal seas. (3) Drift Bars emptying into tidal seas. (4) Sediment Bars at the mouths of delta-building rivers. The Galveston Bars were assigned to class 1. The principles governing harbor improvements were next stated. Under Physical Characteristics, Galveston Bay was described as an area of water, consisting of 490 square miles, bounded by the main land of Texas, Bolivar Peninsula and Galveston Island. Two passes connect it with the Gulf of Mexico: (1) San Louis, with a cross-section of 20,000 square feet; (2) The Principal Pass between Galveston Island and Bolivar Point. Width of the gorge, 8,200 feet; depth, 0–50 feet. For purposes of deep draught navigation the first is unimportant, consequently the improvements have been confined to the latter. To give an adequate idea of this work, it may be here stated that in 1867 there were 9½ feet of water on the inner bar of this pass and 11 feet on the outer. On January 1st, of the present year, there were 25 feet of water at low tide on both bars.

The first attempt to improve Galveston harbor began with the congressional appropriation of 1870. For ten or fifteen years thereafter work was intermittently carried on as Congress made appropriations. The present jetty system, which has opened Galveston as a deep-water port, was based on the 'Project of the Board of 1886,' which consisted of Generals J. C. Duane, Henry L. Abbot and Cyrus B. Comstock.

The following paragraph taken from Lieutenant Judson's paper will give the reader some conception of the magnitude of this, now virtually completed, undertaking: "To build the Galveston jetties there has been spent between July, 1887, and January 1, 1897, $6,029,283.84. There has been incorporated in the jetties 88,355 cars of clay and rock aggregating 17,544.31 cubic yards of clay and 1,800,672.90 tons of granite and sandstone. To use a popular form of illustration, if loaded on cars, the material placed in the jetties since 1886 would form a train reaching from New York City to Cleveland, Ohio, and if this material were piled uniformly over an acre of ground it would be 1,050 feet above its base. I can recall no other single instance of work constructed by the hand of man that embodies within itself such a mass of material transported such a distance." The haul for the sandstone was 130–206 miles; for the granite 294 miles.

Mr. T. U. Taylor, professor of engineering in the University; Mr. Charles Corner, Engineer of the Texas Railroad Commission; President Winston and others took part in the interesting discussion that followed.

FREDERIC W. SIMONDS.

### THE GEOLOGICAL CLUB OF THE UNIVERSITY OF MINNESOTA.

AT the regular meeting on January 23d two topics were presented by Mr. Charles P. Berkey.

The first was an announcement of the oc

currence of native copper and other copper minerals in the hematite ore of the Montana Mine, Soudan, Minnesota. The copper occurs in a thin seam and, in smaller amount, in cavities of the fractured ore. The original mineral of the group is native copper. This has been altered extensively to cuprite, malachite and, in more limited quantity, azurite. These minerals are found penetrating the ore for a distance of five or six feet below the seam and horizontally for a distance of eighty feet. None of the secondary minerals occur above the native copper. All the minerals are exceptionally pure. Some specimens of the copper show former crystals, the faces of which are now heavily coated with secondary products.

Attention was called to the very unusual association of these minerals. So far as the writer is aware, no similar occurrence has been recorded from the iron mines of the United States.

The second topic included several charts illustrating the glacial geology in the vicinity of Taylor's Falls, Minnesota. At this place the line of separation between the so-called eastern and western drift is very sharply defined. The course of the St. Croix river seems to be determined by the mutual adjustments of the eastern and western ice lobes. The moraine made up of typical eastern drift forms a close border along the east bank of the river for several miles, while typical modified western drift borders the west bank and, in at least one point, crosses the river. The combined effect is to force the river over the southwestern extension of the copper-bearing diabase of Keweenawan age exposed in this vicinity. It was further shown that the eastern drift occurs both below and above the western, arguing a readvance of the eastern lobe of ice upon the area of the receding western sheet. It was also shown that partially stratified early drift occupies a position so far below the average elevation of the sandstone surface in the present river gorge that it seems to indicate the location of a pre-glacial stream course at this place. Glacial action simply deepened this course and made it more permanent by directing through it a great glacial river. It was further pointed out that the original topography of the country was such that any flow of ice from the north or northeast would concentrate exceptional eroding force in the gorge of the St. Croix in the vicinity of the present falls.

JANUARY 30TH, 1897.

AT this meeting Mr. George W. Becker reviewed some of the points in the geology of northern Georgia. Facts derived from personal observation upon a recent visit to that locality were discussed at some length. These related chiefly to the methods employed in gold mining, to the value and extent of the asbestos deposits of Yhona Mountain, and the occurrence of corundum in northern Georgia.

CHARLES P. BERKEY,
*Secretary.*

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*NEW BOOKS.*

*Zeit-und Streitfragen der Biologie.* OSCAR HERTWIG. Jena, Gustav Fischer. 1897. Heft II. Pp. iv+277.

*Beiträge zur Kenntnis der Septalnectarien.* J. SCHELWIND THIES. Jena, Gustav Fischer. 1897. Pp. 87 with 12 plates. 15 M.

*Beiträge zur Lehre von der Fortpflanzung der Gewächse.* M. MÖBIUS. Jena, Gustav Fischer. 1897. Pp. viii+212. 4.50 M.

*Kainogenesis als Ausdruck differenter phylogenetischer Energien.* ERNST MEHNERT. Jena, Gustav Fischer. 1897. Pp. 165 with 3 plates.

*Angewandte Elektrochemie.* FRANZ PETERS. Vienna, A. Hartleben. 1897. Pp. 338. 3 M.

*The Forcing Book.* L. H. BAILEY. New York, The Macmillan Company. 1897. Pp. xiii+266. $1.00.

*Analysis of the Sensations.* ERNST MACH, translated by C. M. WILLIAMS. Chicago, Open Court Publishing Company. 1897. Pp. viii+208. $1.25.

*Eclairage.* J. LEFEVRE. Paris, Gauthier Villars et fils, Masson et cie. 1897. Pp. 180.

*Les succédanés du chiffon en papeterie.* Paris, Gauthier Villars et fils, Masson et cie. Pp. 173.

*Glaciers of North America.* I. C. RUSSELL. Boston, Ginn & Co. 1897. Pp. x+210.